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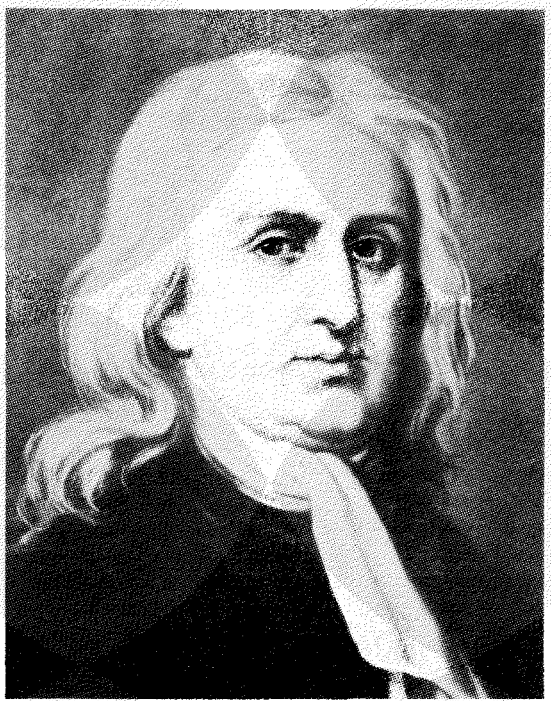

Isaac Newton

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The theme of this issue is the philosophy of science as it applies to the creation-evolution controversy. This is a broad topic and therefore a number of articles were required to cover the relevant aspects of it.

The first two articles focus upon the question of whether evolution is testable. This is in response to the common creationist charge that evolution is not science because it is allegedly nonfalsifiable. Authorities who creationists quote in support of this contention are carefully analyzed. The next three articles discuss how science works, how "creation science" differs from science, and how both differ from nonscience.

The issue concludes with articles and letters that develop themes touched upon in previous issues of *Creation/Evolution*.

Issue XIX will focus upon the hominid fossil record. The evidence for human evolution will be summarized and the standard creationist counterarguments answered.

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Evolution and Testability

Peter Hutcheson

Creationists sometimes say that the theory of evolution is untestable and thus unscientific. This is a surprising claim, since creationists also say that the theory of evolution is incompatible with the second law of thermodynamics. If evolution were precluded by the second law, then evidence that confirms the second law would disconfirm the theory of evolution. If the theory of evolution can be disconfirmed, then it is testable. Creationists cannot have it both ways.

What is the source, then, of their claim that the theory of evolution is untestable? Let us ignore, for the sake of consistency, the creationist claim that the second law is incompatible with the theory of evolution and examine the grounds for the thesis that evolution is untestable. In the final analysis, I think the creationists' arguments fail miserably.

However, a caveat is necessary before we proceed. Creationists are mistaken in their presupposition that the theory of evolution must be classified as either a theory or a fact. One of the many problems with that presupposition results from the sloppy use of the indefinite article *a* in the phrase *a fact*. Such usage treats the theory of evolution as if it consisted of a single proposition whose evidential status is all-of-a-kind and which must be accepted or rejected as a whole. But if anything is evident, it is that the theory of evolution consists of many propositions whose evidential status is *not* all-of-a-kind. Proving the untestability of the theory of evolution, then, would consist of the piecemeal task of considering each separate proposition individually and demonstrating that each is untestable. Furthermore, since research is currently being done in evolutionary theory, not all of the propositions are in, making the task even more difficult. We need, therefore, to beware of hasty talk about the untestability of the whole theory.

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Survival of the Fittest

But perhaps there is a proposition (or small set of propositions) that is so basic to evolutionary theory that showing its untestability would, like Descartes' evil genius, undermine the edifice upon which the theory is built, obviating the need for a "piecemeal" approach.

This, evidently, is the presupposition underlying the attack on natural selection. The argument occurs early in Henry Morris' book, *Scientific Creationism:* "A theory which incorporates everything really *explains* nothing! It is tautologous. Those who survive in the struggle for existence are the fittest because the fittest are the ones who survive" (p. 7). Stephen Jay Gould (1983) formulates the argument quite well before refuting it:

> Natural selection is defined by Spencer's phrase 'survival of the fittest,' but what does this famous bit of jargon really mean? Who are the fittest? And how is 'fitness' defined? We often read that fitness involves no more than 'differential reproductive success'—the production of more surviving offspring than competing members of the population. Whoa! . . . This formulation defines fitness in terms of survival only. The crucial phrase of natural selection means no more than 'the survival of those who survive'—a vacuous tautology. [pp. 141–142]

Does this argument prove the untestability of the theory of evolution? A prerequisite for doing so is to show that the theory of evolution is built upon the edifice of natural selection in such a way that, without natural selection, the theory of evolution itself would collapse. That, however, is far from clear and certainly does not go without saying.

In response to creationist Duane Gish's assertion that the theory of evolution is a tautology without predictive value on the basis of the argument just cited, Gould writes: "Please note, however, that the false claim for tautology was advanced only against Darwin's mechanism of natural selection, not against the idea of evolution itself" (p. 140). In response to the claim that natural selection was quietly abandoned by even its most ardent supporters, Gould quips: "News to me, and I, although I wear the Darwinian label with some pride, am not among the most ardent supporters of natural selection" (p. 141). These remarks, if anything, suggest that the theory of evolution is independent of natural selection.

R. C. Lewontin (1981), another authority on the theory of evolution, inveighs against ". . . the growth of a vulgar Darwinism that sees direct adaptation in every feature of life. By making claims for natural selection that are as tortured as the absurd claims of the nineteenth century evolutionists who saw God's wisdom in everything, the vulgar adaptationists seriously weaken [the perception of]

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the power of evolutionary explanation." Now if only "vulgar" Darwinists make extravagant claims for natural selection, and thereby undermine the perception of the power of evolutionary explanation, then there are other mechanisms that explain evolutionary change, and the theory of evolution very well might be independent of natural selection.

Lewontin does mention other factors that play a role in evolutionary explanation:

> The controversies about evolution lie in the realm of the relative importance of various forces in molding evolution. One such controversy concerns the relative importance of direct "adaptive" natural selection for characters, as opposed to other forces of evolution such as genetic drift, genetic linkage, pleiotrophy, allometry, and multiple adaptive peaks for particular events in evolution. [p. 559]

Two others might be mentioned: mutation and founder effect. Now if authorities cite many other factors involved in evolutionary change, debate the relative importance of natural selection, and suggest that the theory of evolution is independent of it, then creationists must first establish that the theory of evolution stands of falls with natural selection before their case can be made. But that issue is not even broached in their argument for evolution's circularity. Therefore, they have not proved the theory untestable.

A Criterion for "Fitness"

Nonetheless, they have made an important charge against natural selection itself: the charge of untestability. To answer this, it will be necessary to show that there is a criterion *other than survival* for something being the "fittest" or better adapted. Is there an independent criterion?

Gould tells us that there is. He says that the survival and spread of certain traits in individuals throughout populations is a *result* of the fitness (adaptability) of those traits, not a *definition* of fitness (p. 143). Certain traits are superior or better adapted *before* they survive and spread. I quote Gould:

> Now, the key point: certain morphological, physiological, and behavioral traits should be superior *a priori* as designs for living in new environments. These traits confer fitness by an engineer's criterion of good design, not by the empirical fact of their survival and spread. [p. 143]

A trait is better adapted, then, if it meets an engineer's criterion of good design.

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Although the word *design* may prompt some to think of a popular argument for God's existence, the criterion Gould invokes is naturalistic. It is a matter of comparing an engineer's design of something with what one finds in nature. The better adapted or "fitter" organisms are those which would meet an engineer's criterion for good design if an engineer were to apply one. If one then predicts that organisms which meet an engineer's criterion would be those that survive and, in the long run, spread their traits throughout populations, then such a prediction in terms of natural selection is testable.

The criterion Gould cites is general and designed to cover all cases. But it is not clear how this criterion plays a role in evolutionary explanation. Let us turn, then, to a specific example in order to clarify the testable and contingent character of possible explanations in terms of natural selection.

The example I shall cite is one that the creationists deny is an instance of evolution "in the true sense." An evolutionary process is a change in gene frequency that, *in the long run*, results in the appearance of a new species. The example I shall cite is not one in which a new species appeared. *Those* changes take so long that it is impossible for an individual to point to one having occurred in his or her personal experience. But the creationists' denial that it is an instance of evolution "in the true sense" is irrelevant here, for the issue has to do with the testability of explanations in terms of natural selection. And the example I shall cite is undoubtedly an instance of natural selection.

My example is a standard one about the peppered moths in England. Before 1845, every observed moth of this kind was gray (at least every recorded observation). In 1845, however, a single black moth of that biological type was observed and recorded in Manchester, an industrialized area. Presumably, there were more black moths. Now the gray color of most of the moths was better adapted to their environment, since the moths tended to stay on trees that were covered with gray lichens. Thus, the gray color constituted a good camouflage against their predators (primarily birds). On the other hand, the darker moths were less well camouflaged and even tended to stand out against the background of the trees on which they lived. They were therefore less well adapted. Now, since the darker moths were easier for the birds to see, they would, as a group, more likely be eaten before they matured and reproduced. Since physical characteristics are inherited, it could, at this point, be predicted that, if the environment remained the same in the relevant respects, the black moths would constitute a smaller percentage of the population, whereas the gray ones would comprise a larger one. If you were to design a moth for living in such an environment, you would give it good camouflage against its predators. The gray moths in that environment meet the engineer's criterion of good design.

But the environment did not remain the same. Industrialization in England blackened the trees, making the gray moths more easily visible to their predators, whereas the black ones had thus become less easily visible. It could then be

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predicted that the percentage of black moths would increase, whereas the gray ones would decrease (Northington and Goodin, 1984). In this new environment, the dark moths meet the engineer's criterion of good design.

Now it is a logically *contingent* fact that the better camouflaged moths survive and, in the long run, spread their better-adapted characteristic throughout the population. I would not place my bet on the survival and spread (or even stability) of the black moths when the trees are gray, nor on the gray ones when the trees are black. However, it is not true *by definition* that the better-adapted (in this instance, better camouflaged) individuals will survive and spread. Their greater adaptation relative to environmental conditions is identifiable *independently of* and *prior to* their survival, as shown by the predictions those identifications license. If those predictions were disconfirmed by subsequent observations, that would be evidence against natural selection as an explanation of the evolutionary change. The possibility of such disconfirming evidence constitutes testability.

This example is not atypical. Basically, it is a matter of being able to identify those characteristics that, in a given environment, would be more likely to *produce* survival and spread. But survival, once again, is not a *definition* of adaptability but a probable *result* of it. Creationists have not, therefore, proven the untestability of explanations in terms of natural selection, much less the untestability of the theory of evolution.

One harmless concession should be made. Gould does note that some of the literature in evolutionary theory does involve the use of a circular criterion of fitness or adaptability (p. 143). Gould, and I think rightly, attributes this to an unwillingness among some scientists to "explore seriously the logical structure of arguments" (p. 141). Some scientists need, in short, to be more philosophical. But this does not mean that the theory of evolution or Darwin's formulation is untestable, since good explanations and predictions in terms of natural selection *can be* specified in a noncircular way, and frequently are.

Ehrlich and Birch

The argument I have refuted is not, however, the only argument for the untestability of the theory of evolution in *Scientific Creationism*. Consider this argument from page nine:

> It is clear that neither evolution nor creation is, in the proper sense, either a scientific theory or a scientific hypothesis. Though people might speak of the "theory of evolution" or of the "theory of creation," such terminology is imprecise. This is because neither can be *tested*. A valid scientific hypothesis must be capable of being formu-

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> lated experimentally, such that the experimental results either confirm or reject its validity.
>
> As noted in the statement by Ehrlich and Birch cited previously, however, there is no conceivable way to do this.

The claim that the theory of evolution is untestable is based upon the assertion that evolution is not a valid scientific hypothesis that is capable of being formulated experimentally, such that the experimental results either confirm or reject its validity. Ehrlich and Birch's authority is cited as grounds for asserting this.

If one reads only the creationists' quotation from Ehrlich and Birch's article, one would think that Ehrlich and Birch believe that the theory of evolution as a whole is untestable. That impression, however, would be *far* from the truth, since the creationists have, by quoting Ehrlich and Birch out of context, distorted their views. This is the quotation in *Scientific Creationism:*

> Our theory of evolution has become . . . one which cannot be refuted by any possible observations. It is thus "outside of empirical science," but not necessarily false. No one can think of ways in which to test it. . . . (Evolutionary ideas) have become part of an evolutionary dogma accepted by most of us as part of our training. [pp. 6–7]

The creationists did *not* cite the very next sentence: "The cure seems to us *not* to be a discarding of the modern synthesis of evolutionary theory, but more skepticism about many of its tenets" (Ehrlich and Birch, p. 352). If Ehrlich and Birch think that the theory of evolution as a whole is untestable, why do they say, in the very next sentence, that evolutionary theory should not be scrapped? The answer is that they do *not* regard the theory of evolution as a whole to be untestable, as even a cursory reading of the article shows. At the beginning of Ehrlich and Birch's article, offset and in boldface, is a good precis:

> While accepting evolutionary theory, should ecologists be more skeptical about hypotheses derived solely from untestable assumptions about the past? The authors put forward the view that many ecologists underestimate the efficacy of natural selection and fail to distinguish between phylogenetic and ecological questions. [p. 349]

These two biologists are not at all dissatisfied with the theory of evolution as such.

They *are* dissatisfied, however, with how some scientists make use of *some* hypotheses about the evolutionary past. The article is about how some ecologists investigate matters poorly by turning too readily to untestable assumptions about the past to answer their questions rather than first turning to explanations that *are*

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falsifiable. Ehrlich and Birch write, for example:

> It is clear that considerably more thorough investigations of the present day population biology of these birds, with the emphasis on the genetics of clutch size, magnitude of selection pressure on clutch size, and rates of gene flow, will be necessary before we fall back on an untestable historical hypothesis. [p. 350]

In brief, those ecologists who investigate poorly have used untestable historical hypotheses to circumvent the need for more empirical investigation, which is objectionable. [This is not to imply that historical hypotheses are automatically untestable; see the next article, page nine.]

Ehrlich and Birch also say that the tendency of some ecologists to turn too quickly to untestable historical hypotheses has been accompanied by a failure to address logically prior questions and confusions about what constitutes a proper scientific explanation (pp. 350–351).

What are these untestable historical hypotheses? They are very specific assertions about specific animals in specific locations. One example is about the ancestral habitat of the British great tit, *Parus major*. Another is about competition in the past between two species of birds on the Canary Islands, *Fringella coelebs* and *Fringella coerulea* (p. 350). The point is that these hypotheses are about *specific details* of evolutionary history. These hypotheses are quite peripheral. They are not fundamental propositions in the theory of evolution. They are not even relatively important to the theory as a whole but represent only some sloppy work on the part of some ecologists. The untestability of these speculations about *very specific* details, therefore, does *not* imply that fundamental or relatively important propositions of evolutionary theory are untestable. In fact, such propositions as "More complex lifeforms have developed out of simpler ones" and "Dinosaurs existed and became extinct long before modern humans came into existence" *are* testable. The evidence *could* disconfirm them, but it simply *does not*. No doubt Ehrlich and Birch recognize this, which is why they recommend that evolutionary theory be retained.

Furthermore, Ehrlich and Birch not only favor retaining evolutionary theory but also criticize their colleagues for failing to appreciate "the efficacy of natural selection." As I pointed out earlier, creationists believe that explanations in terms of natural selection are untestable. To say the least, it is not in their best interest to cite as authoritative such strong advocates of the explanatory power of natural selection.

Conclusion

We have examined two arguments in *Scientific Creationism* for the untestability

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of evolutionary theory. The first, concerning the alleged circularity of natural selection, rested upon an unproven presupposition and included the false premise that survival is the test of adaptability. The second involved an appeal to the authority of Ehrlich and Birch. Examining what they had to say, however, showed that their article did not advance the creationist's case. If the creationists believe that the theory of evolution stands of falls with a peripheral hypothesis about the great British tit, they must be guilty of a confusion to which I alluded at the beginning of this article—that of thinking of evolutionary theory as a single proposition whose evidential status is all-of-a-kind.

Furthermore, the evidence *could* have corroborated (but does not) the hypothesis that all lifeforms appeared at virtually the same time. As a result, it is not only true that creationists have *failed to prove* the untestability of the fundamental tenet of evolutionary theory, it is also true that the fundamental tenet is testable.

The same cannot be said of the fundamental axiom of creationism, that God wrote Genesis.

> According to the Biblical record, God Himself wrote with His own hand these words: "For in six days the Lord made heaven and earth, the sea, and all that in them is. . . ." That being true, it follows that real understanding of man and his world can only be acquired in a thorough-going creationist frame of reference. [Morris, p. iii]

I should like to show the untestability of that creationist axiom and others. That, however, is a different topic.

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What Did Karl Popper Really Say About Evolution?

Frank J. Sonleitner

In a 1981 article in *Science Digest*, Duane Gish, the master debator among creationists, said:

> There were no human witnesses to the origin of the Universe, the origin of life or the origin of a single living thing. These were unique, unrepeatable events of the past that cannot be observed in nature or repeated in the laboratory. Thus neither creation nor evolution qualifies as a scientific theory and each is equally religious. As the scientific philosopher Sir Karl Popper has stated, evolution is not a testable scientific theory but a metaphysical research program. [Asimov and Gish, p. 82]

The most direct rebuttal one can give to these charges is that Gish and other creationists really don't believe them! The underlying point of the above quotation is that evolution is unscientific because it is not falsifiable (testable), yet creationists are always producing arguments and "evidences" that they say refute evolution. Gish does it in the article quoted above. In spite of that obvious contradiction, the argument impresses laypeople and legislators. But it completely distorts what Popper calls the logic of scientific discovery.

So what does Popper really say about evolution?

> Indeed, the recent vogue of historicism might be regarded as merely part of the vogue of evolutionism—a philosophy that owes its influence largely to the somewhat sensational clash between a *brilliant scientific hypothesis* concerning the history of the various species of animals and plants on earth, and an older metaphysical theory which, incidentally, happened to be part of an established religious

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belief.

> What we call the evolutionary hypothesis is an explanation of a host of biological and paleontological observations—for instance, of certain similarities between various species and genera—by the assumption of common ancestry of related forms.
>
> . . . I see in modern Darwinism the *most successful explanation* of the relevant facts. [Popper, 1957, p. 106; emphasis added]

> There exists no law of evolution, only the *historical fact* that plants and animals change, or more precisely, that they have changed. [Popper, 1963b, p. 340; emphasis added]

> I have always been extremely interested in the theory of evolution and very ready to accept evolution *as a fact.* [Popper, 1976, p. 167; emphasis added]

> The Mendelian underpinning of modern Darwinism has been well tested *and so has the theory of evolution* which says that all terrestrial life has evolved from a few primitive unicellular organisms, possibly even from one single organism. [Popper, 1978, p. 344; emphasis added]

Furthermore, in his book, *Objective Knowledge*, where he uses the Darwinian paradigm as a basis for his own theory of knowledge, Popper not only discusses Darwinism at length as a scientific explanation but offers as an additional component a scientific hypothesis of his own—genetic dualism—which is intended to strengthen the orthodox neo-Darwinian framework (Popper, 1972, p. 242 ff). Popper's genetic dualism is similar to the ideas of Wilson and Stebbins (Stebbins, 1977, p. 125) and Mayr (1963, p. 604 ff.; 1970, p. 363 ff.) concerning the role of behavior in evolution.

But he did make one mistake—for which we should forgive him; some well-known biologists (who should know better) have made the same mistake. Popper takes "survival of the fittest" as the definition of natural selection (Popper, 1972, p. 241). This catchy phrase was an invention of Herbert Spencer, which Darwin, in a rare example of bad judgment, interpolated into later editions of *On the Origin of Species:* "This preservation of favorable individual differences and variations and the destruction of those which are injurious I have called Natural Selection or the Survival of the Fittest" (p. 64). Clearly it is an *alternate* name (and not a very apt one) for the process in question but not a definition.

The argument regarding "survival of the fittest" is that the only way one can usually tell who the fittest are is to see who survives. But then survival of the fittest becomes "almost a tautology" and hence untestable (Popper, 1972, p. 69;

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1963a, p. 964).

> I have come to the conclusion that Darwinism is not a testable scientific theory, but a *metaphysical research programme*—a possible framework for testable scientific theories. [Popper, 1976, p. 168]

It is clear that here Darwinism means natural selection, not evolution. Popper states this explicitly earlier in the same work:

> . . . because I intend to argue that the theory of natural selection is not a testable scientific theory, but a metaphysical research programme; . . . [Popper, 1976, p. 151]

There are two points to be made here:

First, natural selection being untestable is not the same as evolution being untestable. Evolution, to the creationist, is any hypothesis about origins. Astrophysical theories about stellar evolution or the "Big Bang" cosmology or scientific geology or, for that matter, many facets of biological evolution are not based upon Darwinian natural selection.

Second, Popper later admitted that he was *wrong!*

> The fact that the theory of natural selection is difficult to test has led some people, anti-Darwinists and even some great Darwinists, to claim that it is a tautology. . . . I mention this problem because I too belong among the culprits. Influenced by what these authorities say, I have in the past described the theory as "almost tautological," and I have tried to explain how the theory of natural selection could be untestable (as is a tautology) and yet of great scientific interest. My solution was that the doctrine of natural selection is a most successful metaphysical research programme. . . . [Popper, 1978, p. 344]
>
> I have changed my mind about the testability and logical status of the theory of natural selection; and I am glad to have an opportunity to make a recantation. . . . [p. 345]
>
> The theory of natural selection may be so formulated that it is far from tautological. In this case it is not only testable, but it turns out to be not strictly universally true. There seem to be exceptions, as with so many biological theories; and considering the random character of the variations on which natural selection operates, the occurrence of exceptions is not surprising. [p. 346]

Thus the creationists *were never correct* in stating that Popper believed that evolution was not falsifiable (and hence not scientific), *nor are they now correct*

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in citing him as an authority for the claim that natural selection is tautological and not falsifiable!

Some might challenge my point that Popper never doubted the testability of evolution by citing the following:

> I blush when I have to make this confession; for when I was younger, I used to say very contemptuous things about evolutionary philosophies. When twenty-two years ago Canon Charles E. Raven, in his *Science, Religion, and the Future*, described the Darwinian controversy as "a storm in a Victorian teacup," I agreed, but criticized him for paying too much attention "to the vapors still emerging from the cup," by which I meant the hot air of the evolutionary philosophies (especially those which told us that there were inexorable laws of evolution). But now I have to confess that this cup of tea has become, after all, *my* cup of tea; and with it I have to eat humble pie. [Popper, 1972, p. 241]

But in an earlier work, he explicitly identified these "vapors" as "the Great Systems of Evolutionist philosophy, produced by Bergson, Whitehead, Smuts and others" (Popper, 1957, p. 106). He was not speaking, then, of the *scientific* theory of evolution but of various *metaphysical* theories. He made a clear distinction between the two.

And his current support for the Darwinian idea of natural selection is expressed in equally plain language.

> What Darwin showed us was that the mechanism of natural selection can, in principle, simulate the actions of the Creator and His purpose and design, and that it can also simulate rational human action directed towards a purpose or aim. [Popper, 1972, p. 267; *see also* Popper, 1978, pp. 342–343]

As for the notion of design as a useful hypothesis:

> His theory of adaptation was the first nontheistic one that was convincing; and theism was worse than an open admission of failure, for it created the impression that an ultimate explanation had been reached. [Popper 1976, p. 172]

There are scientists who are unfamiliar with or misinterpret Popper. For example, Colin Patterson holds that, if we accept Popper's distinction between science and nonscience, evolution is not science because it deals with unique historical events. Popper, however, doesn't agree with this.

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> It does appear that some people think that I denied scientific character to the historical sciences, such as palaeontology, or the history of the evolution of life on Earth. This is a mistake, and I here wish to affirm that these and other historical sciences have in my opinion scientific character; their hypotheses can in many cases be tested. [Popper, 1981, p. 611]

In an earlier work, Popper discussed the historical sciences in which the scientific method of theoretical sciences is used:

> This view is perfectly compatible with the analysis of scientific method, and especially of causal explanation given in the preceding section. The situation is simply this: while the theoretical sciences are mainly interested in finding and testing universal laws, the historical sciences take all kinds of universal laws for granted and are mainly interested in finding and testing singular statements. [Popper, 1957, p. 143ff]

What Popper calls the historical sciences *do not* make predictions about long past unique events (postdictions), which obviously would not be testable. (Several recent authors—including Stephen Jay Gould in *Discover*, July 1982—make this mistake.) These sciences make *hypotheses* involving past events which must predict (that is, have logical consequences) for *the present state* of the system in question. Here the testing procedure takes for granted the general laws and theories and is testing the specific conditions (or initial conditions, as Popper usually calls them) that held for the system.

A scientist, on the basis of much comparative anatomy and physiology, might *hypothesize* that, in the distant past, mammals evolved from reptiles. This would have *testable consequences* for the *present* state of the system (earth's surface with the geological strata in it and the animal and plant species living on it) in the form of reptile-mammal transition fossils that should exist, in addition to other necessary features of the DNA, developmental systems, and so forth, of the present-day reptiles and mammals.

What about repeatability? It is the observations that must be repeatable, if only to establish their validity independently of any one person's authority. This does not mean that the hypothetical mechanism or the phenomenon concerned must be repeatable or reproducible. In the experimental laboratory where the phenomena being studied are short-lived and transient, it is usually necessary to reproduce them in order to repeat the observations. But scientists must wait for the recurrence of natural phenomena—such as eclipses, earthquakes, seasonally recurring biological phenomena, and so forth. Yet, if a phenomenon is a stable, more or less permanent long-term condition, observations may be repeated any-

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time. A geologist may return to a geological formation to repeat or make new observations, or an anatomist or paleontologist may reexamine a museum specimen, either corroborating or refuting someone else's previous observations. Clearly, then, a hypothesis postulating a unique past event *is* scientific—as long as it has observable consequences for the present that can be repeatedly verified by any observer.

Thus we may conclude (as Popper did) that evolutionary theories or historical hypotheses about origins are no different than other scientific theories as far as their logical features are concerned and are just as falsifiable as hypotheses in the form of general laws and theories.

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Fossils and Time is a must for earth science teachers and students. It was compiled by and is available from: John H. Hanley, Branch of Paleontology and Stratigraphy, U.S. Geological Survey, Mail Stop 919, Box 25046 Denver Federal Center, Denver, CO 80225.

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Creationism and the Nature of Science

Harold I. Brown

The single most important outcome of the intensive work on the history and philosophy of science that has been done over the past twenty-five years is that science must be understood first and foremost as a *process*, not as a system of proven results. Scientists pose hypotheses about various aspects of nature and test these hypotheses by examining nature. When a hypothesis is well supported, they use it as a basis for learning more about nature, and, when a hypothesis fails to give correct results, it is revised or rejected and replaced.

There is a wide variety of different sorts of scientific hypotheses, and I will try to indicate how wide this variety is, but I will not attempt to illustrate all of the different kinds of hypotheses that occur in science. Some hypotheses deal with the occurrence of specific events—for example, that a total eclipse of the sun will occur at a particular time in the future, that a total eclipse did occur at a particular time in the past, or that Earth was hit by an asteroid at the end of the Cretaceous. Contrary to a widespread view, there is no special problem in testing hypotheses about past events, because such events leave currently available evidence. Such testing is, of course, indirect, but we will see that this is the normal situation in science. Other hypotheses make claims about the basic properties of a kind of entity—for example, the charge and mass of the electron or the melting point of copper. Some hypotheses make claims about how objects behave under specified circumstances—that planets moving in the gravitational field of the sun travel in elliptical orbits. Some hypotheses make quite general claims that apply to a wide variety of situations—for example, the claim that energy is conserved in all physical processes or that the velocity of light in a vacuum is the same for all observers. And in some disciplines we find systems of hypotheses which, taken together, describe the fundamental features of a particular portion of the natural world; these are known as fundamental theories, for example, Newton's mechanics, quantum theory, relativity theory, the theory of evolution by natural

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selection, or plate tectonics. This is a small sampling of theses that do play, or have played, an important role in science. Some of the claims I mentioned are theses which, at present, we have good reason for believing correct, and some we have reason for believing incorrect, but the central point that concerns me about them is captured in the term *hypotheses*, because, no matter how powerful the evidence in favor of a scientific thesis, we never reach the point at which that claim has been uneqivocally proven. Sometimes evidence in favor of a theory is so powerful and comprehensive that the theory becomes accepted as the basis for research in a discipline, and for a substantial period of time that theory is not seriously open to question. Still, the theory remains a hypothesis, open to reconsideration or rejection under appropriate circumstances.

I have been emphasizing the testability and refutability of scientific hypotheses, but this point must not be understood in a simplistic fashion. The process of testing scientific theories is often complex, and it is not always obvious just when a theory should be rejected. There are situations in which there appears to be evidence against a theory but in which further research shows that the evidence is either irrelevant or in fact supports the theory. Just as it is important for scientists to be prepared to reject hypotheses, so it is important that hypotheses not be rejected prematurely, and the tenacious defense of a hypothesis can play a positive role in the development of science. Science operates in terms of what Thomas Kuhn has called an "essential tension" between conservatism and innovation, between testing and defending theories, between acceptance of hypotheses and their rejection and replacement (1977).

In order to understand these ideas more fully, it will be useful to have an actual example from the history of science before us, so I want to sketch some aspects of the career of Newton's mechanics. This is one of the most powerful and successful scientific theories ever developed; it is a theory which provided the basis for virtually all physical research for a period of over 150 years; it is a theory which was supported by overwhelming evidence and which overcame a number of apparent refutations but which was ultimately seen to be incorrect.

Newton's *Mathematical Principles of Natural Philosophy* was published in 1687 and, contrary to the impression one gets from modern physics textbooks, it did not immediately sweep the scientific world; it took approximately fifty years before the theory was generally accepted as correct. Originally, there were two kinds of objections to the theory. One of these was conceptual: the key idea of universal gravitation—that bits of matter exercise a force on each other even when they are not in physical contact—seemed absurd to both the common sense and the accepted science of the day. Newton himself was never happy with this idea and tried, unsuccessfully, to replace gravitational attractions with some system of particles pushing on each other. This problem was solved in a familiar way: many new ideas seem obviously absurd when first proposed, but, when they are shown to be fruitful and when they become familiar, we soon begin to wonder

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how we were ever able to think in a different fashion.

The second class of problems was straightforwardly empirical, for, in spite of its striking successes, there were also cases in which Newton's theory gave the wrong results. The most important of these had to do with a particular aspect of the orbit of the moon (the motion of the line of upsides), for which Newton's calculated value was half the observed value. Now there is a very important respect in which the derivation of an incorrect prediction from a theory is vastly more revealing than the derivation of a correct prediction. For if a theory yields correct predictions, that shows that the theory may be right but offers no guarantees, while the derivation of an incorrect prediction does guarantee that something is wrong somewhere. This is central to the logic of theory testing, and I want to leave the story of Newton's mechanics for a moment in order to develop this idea.

The best way to clarify this point is to use a simplified model. Suppose I have a machine in which I keep coins; I deposit coins into a slot, and a digital display gives the total amount of money in the machine. You visit me one day, and you offer the hypothesis that I have three quarters in the machine. A brief calculation yields the prediction that the display will read seventy-five cents, and, when you check the display, your prediction is confirmed. You have evidence that supports your hypothesis. But has your hypothesis been proven? Of course not, for there are many other hypotheses that would yield the same result: I might have put seventy-five pennies in my machine or seven dimes and a nickle. Suppose, however, that you offer the same hypothesis—that there are three quarters in the machine—and, on checking, you find that the display reads sixty-two cents. In this case, it is clear that your hypothesis is wrong. We do not know what the correct hypothesis is, but three quarters do not add up to sixty-two cents, and that hypothesis is eliminated.

Now there are many respects in which this model does illustrate the key features of scientific theory testing. Just as in my model you are not permitted to look into the machine and see what coins are there, so it is not possible to test most scientific theories directly. Rather, we deduce results from those theories and check to see if those results are correct. If the results are correct, we have some evidence that confirms our theory, and, if the results are incorrect, we have powerful evidence against our theory. To be sure, interesting scientific theories are not nearly as trivial as my model. Newton's theory, for example, gave dozens of correct predictions. Still, the key point I want to illustrate with the model does hold: you can begin with an incorrect hypothesis, reason from it correctly, and come up with correct predictions; but you cannot begin with a correct hypothesis, reason correctly, and end up with incorrect predictions. If a hypothesis yields correct results, it is supported by those results but is not proven; if a hypothesis yields incorrect results, we have proof that something is wrong.

Unfortunately, there is one complication that I have not yet mentioned. Go

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back to the case in which you are offering hypotheses about the coins in my machine. You proposed that there are three quarters in the machine, and the display reads sixty-two cents. Clearly your hypothesis is wrong, *unless* the machine is broken. That is, although a result which is different from what we predicted does show that something is wrong, it does not show *what* is wrong, and it will not always be clear just where our theory needs to be modified. This may take a great deal of further research, and the results will often be surprising. This is analogous to what happened in the case of Newton's incorrect prediction, and I want to return now to that story, keeping in mind the points I have just made about the logic of theory testing.

The key figure in the resolution of this story was Clairaut. For a while, Clairaut thought that the observed motion of the moon showed that something was wrong in Newton's theory, although he believed that only a small modification was required (the addition of an inverse fourth power term to the law of gravitation). But then, around 1750, Clairaut made a surprising discovery. The calculations required to get from Newton's theory to a predicted orbit for the moon are quite complex. In the course of these computations, mathematicians had been making what seemed to be a series of correct approximations, and Clairaut found that the error was located in these approximations, not in the theory. For some sixty years it had seemed that Newton's theory gave an incorrect result, but it would have been premature to reject the theory for that reason. Appearances to the contrary, the theory was capable of giving the correct result, provided it was developed in the correct way. An important point about science now emerges: sometimes it just takes time before a question can be resolved, and, although people get impatient and want the answers to their questions now, it is not always possible. All of these points can be further illustrated by following the career of Newton's theory for the next hundred fifty years or so.

For about a century, there were no serious challenges to Newton's theory, but a great deal of work was done on and in the theory. Superior mathematical techniques were developed, leading to more precise predictions, while better observational techniques were also being developed, which led to tougher tests of these predictions. As a result of these developments, two new problems arose. The power of Newton's work had shown itself, first of all, in its ability to yield precise calculations for the orbits of the planets, and, by the middle of the nineteenth century, it became clear that the theory was not giving correct results for Mercury, the closest planet to the sun, and for Uranus, the most distant of the planets known at that time. I want to consider the outcome of each of these problems, because the two problems eventually had quite different resolutions.

The problem of Uranus was resolved first. One approach, taken by Airy, the British Astronomer Royal, was to suggest, once again, that Newton's gravitation law was wrong, but this view did not prevail. The alternative approach was developed independently by two scientists, Urban Leverrier and John Adams. These

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two set out to solve the problem within the framework of Newtonian mechanics by proposing that, rather than Newton's theory being incorrect, the mistake lay in the belief that all the planets were known. If, however, there were an eighth planet, this planet would exercise a gravitational attraction on Uranus and affect its orbit. In other words, the orbit of Uranus was calculated by first calculating what the orbit would be if only Uranus and the sun existed and by then correcting the orbit to take account of the much smaller attractions of each of the known planets. This calculated orbit did not quite match the observed orbit, and Leverrier and Adams considered the hypothesis that the difference was caused by the gravitational attraction of an as yet unobserved planet. Knowing the supposed effects of this planet on Uranus, they were able to compute the mass and orbit that the planet must have, and the planet was found by an observer, Galle, the first night he looked for it, within one degree of the predicted location. That planet is Neptune.

Several points require emphasis. First, we must be clear that cases in which theory disagrees with observation must be taken very seriously indeed, for they do guarantee that something is wrong somewhere in our currently accepted body of beliefs, but it is not always obvious just where the error is. A great deal of time, research, and effort may be required to isolate the problem, and it may turn out to be relatively minor, as in the two cases cited thus far. We do not reject a powerful, successful theory just because it faces problems, as the discovery of Neptune illustrates. What seems to be a refutation may turn into a major triumph for the theory in question. Still, even the most successful scientific theory is open to reconsideration and may be rejected. This eventually occurred in the case of Newton's theory, and that brings us to the story of Mercury.

You will, perhaps, not find it surprising that, after the discovery of Neptune, Leverrier, one of the two scientists who had predicted the existence of this planet, attempted to solve the problem posed by Mercury's orbit in a similar way. That is, Leverrier hypothesized another planet, Vulcan, located between Mercury and the sun and attempted to compute its mass and orbit from the known differences between the observed orbit of Mercury and the previously computed orbit. But this time the approach failed. There is no evidence that such a planet exists, and there are now very good reasons for believing that it is not possible to calculate the orbit of Mercury correctly using Newton's theory of gravitation—although it is possible to get this information, and that for the other planets as well, by using Einstein's vastly more complex theory of gravitation.

To be sure, we do still use Newton's theory for a wide variety of situations, and this is legitimate because we know that, for those situations, Newton's theory gives the correct results. But we must keep two points clearly in mind. The first is that Newton's theory also gives wrong results for a large variety of cases. This is important because the theory is supposed to give us a picture of how the universe is built, and, if this picture is correct, all results derived from the theory ought to

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be correct. Again, this is the fundamental fact behind the logic of theory testing: if a theory yields incorrect results, something is wrong, no matter how many correct results it yields. The second point is that, if we turn to Einstein's theory for an alternative picture of how the universe is built, we get a picture that is completely different from the Newtonian picture and that makes use of ideas that would never have occurred to Newton writing in the seventeenth century. This is not a criticism of Newton. Newton's work is brilliant and stands as a major landmark in the development of science. But, since Newton's time, we have learned a lot, and *fundamentally new ideas* have been invented with the result that the current scientific picture of the structure of the universe is quite different from anything our ancestors could have imagined.

It would be hard to find a clearer or more dramatic illustration of what it means to say that all scientific theories are *hypotheses*. No matter how well they are supported, no matter how many objections they overcome, no matter how many tests they pass, scientific claims are always open to reconsideration. It is, I think, impossible to overemphasize this point. There are, no doubt, scientists who speak and write as if they have achieved the final word in their discipline, and this is unfortunate. But the way to get a proper perspective on science is by looking both at its historical development and at what contemporary scientists *do*. Fifteen years ago, for example, astronomers believed that the question of how the sun produces its energy had been answered; it became a closed, finished subject. Now they are not so sure. Results from an experiment still in progress (Bahcall and Davis, 1978) have opened the question up again. The experiment, known as the solar neutrino experiment, is extremely complex and difficult, and the question we must ask ourselves is: why, if scientists were sure that they had the correct theory of the sun, was the experiment tried at all? The answer, I think, is clear: all scientific views are open to reconsideration, and, when someone thinks of a new way to test an old theory, one can expect that the tests will be done, and, in many cases, the outcome will surprise us. Note also that, although this experiment has given results that are different from those predicted, we cannot yet say that the previously accepted theory of the sun has been refuted. The problem is that there are a number of theories involved in the design and the evaluation of the experiment, and what is clear now is that something is wrong somewhere. Just what is wrong, or how to fix it up, is not yet clear.

This brings me to another aspect of science that must be considered: *science takes time*, often long periods of time in comparison to a human life span. Recall that it took approximately sixty years from the publication of Newton's theory to its general acceptance and another 175 years until it became clear that the theory was not right. Why wasn't the problem with Mercury's orbit discovered at once? The problem involved an extremely tiny shift in the location of the point in the planet's orbit at which it is closest to the sun, and the difference between the observed motion of this point and the motion computed from Newton's theory

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was approximately twenty-two seconds of arc per century. It just took time to discover that disagreement. Take another example. Pluto, the most recently discovered planet, was first observed about fifty years ago. As it takes Pluto almost 250 years to make one orbit of the sun, we have not yet observed a single orbit and will not do so in our lifetime; therefore, we have no idea what small discrepancies may appear after a few dozen orbits have been recorded. In fact, it takes Neptune about 165 years to complete an orbit. Again, we have not yet observed an entire orbit, but a good deal of data is available, and in the past few years some astronomers have begun to suspect that there is a discrepancy between the observed and calculated orbits for Neptune.

This is all very frustrating to those of us who would like to know—now—how the universe is built. The only response available here is that that is tough, this is just a part of human life. Seventy-five years ago, the major cause of death in the developed world was pneumonia. It is no longer a major killer at all compared to cancer and heart disease because we have learned to cure pneumonia. This does not help those who died of pneumonia in the past century, but it took time to find the drugs that cure this disease. Hopefully, sometime in the future, we will find cures for cancer and heart disease. But the development of the necessary knowledge takes time, the process if full of errors and false starts, and it may turn out that we will not cure these ills until someone comes up with a radical new idea—an idea that will seem as absurd, at first glance, as the notion that diseases can be caused by microbes seemed to people not so very long ago.

Let me summarize the upshot of my discussion so far. In particular, I want to emphasize three points about the development of science that I have been trying to illustrate and explain:

1. All scientific claims are tentative hypotheses, and, although there may be long periods in which there is no reason for actively doubting a particular theory, it is basic to science that, when new evidence or new ideas become available, even the best established views can be questioned and perhaps rejected.
2. The process of developing and testing scientific theories takes time, and there is no guarantee that we will have the answers that we want when we want them.
3. Fundamentally new ideas have appeared in the development of science. Our present understanding of the overall structure of the universe, of the nature of fundamental particles, of the causes of disease, and, similarly, of other fields are very different from the kinds of things our ancestors believed. And there is no reason to believe that this process of developing new ideas has ended.

I am now ready to pose a most important question: why are so many deeply religious people opposed to treating the biblical story of creation as science? Part of the answer should, by now, be obvious. To claim that the biblical story of creation is a scientific claim is to hold that this story is a tentative hypothesis,

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subject to test and evaluation and subject to possible replacement by a quite different hypothesis. Very few religious people are prepared to hold their religious beliefs as tentative hypotheses, nor are the people who describe themselves as creation scientists vigorously pursuing new kinds of observations which might refute their hypotheses. Let me press this point, because, if we do decide to take biblical statements as hypotheses about events that have occurred, then there are some striking questions that should be asked. For example, many creationists insist on the literal truth of the story of Noah and the flood. But consider how we would respond to the story if we encountered it, outside of its religious context, in a science textbook, presented as a hypothesis to be evaluated against the evidence. What kinds of questions would we ask? We are told, for example, that in the course of seven days Noah collected a mating pair of each of the "unclean" beasts, seven pairs of the "clean" beasts, and seven pairs of each kind of bird. Did he really get polar bears and penguins in just seven days without the use of jet aircraft or other such devices? What did the gazelle do for exercise during the 150 days the ark was afloat? How was fresh meat for the tigers stored during those five months? If one thinks that questions of this kind are inappropriate when dealing with a biblical text, I will not argue the point—as long as the text is not offered as science.

Creationists, of course, proceed in a different way. Rather than developing and testing their own theory, they criticize what they consider their major opponent, evolution. Now in one respect this is most desirable. Evolution is a scientific theory; it has its successes. It has overcome what seemed to be devastating criticism—for example, the physicist Kelvin's argument in the past century that the sun could not have been burning long enough to provide the required time span. The theory of evolution has been modified in the period since Darwin's first formulation, and it may some day be abandoned and replaced. To the extent, then, that creationists, or anyone else, point up actual problems for an existing theory, they make a genuine contribution to the development of science. But it is a mistake to think that finding problems in evolution theory, or even finding a knockdown, drag-out refutation of evolution, would provide evidence in favor of *creationism*. It would support creationism if this were the only possible alternative, but one need only look at the world's religious literature to find many tales about the origin of the universe which do not include seven days of creation, creation from nothing, the story of the ark, and so forth. If a disproof of evolution would support some alternative theory now available, it gives no more support to biblical creationism than to the stories found in Hindu texts or in various African or American Indian traditions. We could, no doubt, begin seeking evidence which would allow us to compare the scientific merits of these different viewpoints. For example, the story of creation from nothing, considered as a scientific hypothesis, clearly violates the laws of conservation of energy and conservation of matter; stories of creation from a cosmic egg, or from some previously existent

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material, do not obviously violate these principles. But, once again, I submit that this is not the way that many people view their own religious commitments.

We have, then, part of the answer to our question of why religious people would oppose treating the biblical story of creation as science: they do not think of their religious beliefs as tentative hypotheses open to evaluation and possible refutation. But there is more to the story, and this requires a bit more historical reflection. There have been cases in which people tried to settle scientific issues by appealing to scripture, and the result has been harmful to both science and religion—although I think that religion has suffered more than science as a result. The most famous example is the conflict between Galileo and the Roman Catholic Church in the seventeenth century over the question of the motion of Earth. I will summarize this story briefly.

In 1543, Copernicus published a book in which he developed in detail an astronomical theory based upon the assumption that Earth spins daily on its axis and moves, in the course of a year, around the sun. The earlier view, according to which Earth stands still at the center of the universe, was by no means foolish, and there was a great deal of straightforward scientific evidence to support it. But it seemed to many that the older view was required by scripture as well. Discussion continued for a time, but eventually the Church decided to look into this new view. In 1616, when the discussion was coming to a head, Galileo went to Rome to try to convince Church authorities that it would be a mistake to make the outcome of a scientific debate a matter of Church doctrine. I want to emphasize that Galileo was not attacking the Church. He always considered himself a devout Catholic, and his only aim was to try to prevent his Church from making a decision that would hamper science and embarrass Catholicism. Galileo lost this battle, portions of Copernicus' work were declared by the Church to be not only wrong but heretical, and Galileo was called before Cardinal Bellarmine, head of the Inquisition, and ordered to no longer hold, teach, or defend the Copernican view. For a long time Galileo held his peace, but in 1632 he published a book in which he defended Copernicanism. As a result, the following year, aged sixty-nine, ill, and almost blind, he was tried in Rome for holding, teaching, and defending the Copernican view, was forced under threat of torture and execution to recant publicly, and was confined to house arrest for the remaining nine years of his life. It is worthwhile to recall some of the biblical passages that were cited in the early seventeenth century to prove that Earth did not move. Joshua, for example, commanded the sun to stand still: "Sun stand thou still on Gideon, and thou, Moon, in the valley of Ajalon" (10:12), and in the next verse we are told, "And the sun stood still and the moon stayed. . . ." It was regularly pointed out that Joshua commanded the sun to stand still; he did not command Earth to stop turning, as he surely would have done if Copernicus had been correct. In Ecclesiastes we read, "The sun also riseth, and the sun goeth down, and hasteth to the place where he rose" (1:5), and the Psalms speak of the Lord who, among other

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things, "laid the foundations of the earth, that it should not be moved forever" (103:5, Douay; 104:5, King James). It is also worth noting that back in 1533, when a brief summary of Copernicus' views was being discussed, Martin Luther also referred to the story of Joshua to show that Earth does not move.

These examples should suffice to make the point: there are passages in the Bible which we have reason to believe are wrong if read literally and taken as scientific claims about the world. Galileo's point, on the other hand, was right: the attempt to settle scientific issues by appeal to scripture is likely to end up in serious theological embarrassment. This particular embarrassment still lingers, to the point that Galileo's trial was recently reopened and the judgment reversed. It is in this context that I think we can fully understand why so many thoughtful religious people insist on keeping science and religion distinct.

There is one more aspect of science that must be considered before I conclude these remarks. A central aim of science is the attempt to understand nature in terms of natural processes, and it is inappropriate to invoke miracles or other forms of supernatural intervention in the course of developing scientific explanations. To the extent, then, that creationists postulate divine acts to account for features of the natural world, they are just not doing science. Similarly, presumed revelations are not a legitimate source of scientific knowledge. A large part of the challenge of science consists of the attempt to understand the world around us by the use of human intelligence. How far is it possible to go in attempting to carry out this project—that is, are there limits to science? It seems to me that the only appropriate answer to this question, at the present stage of the development of science, is that we do not know what the limits of science are or if there are any at all. Many limits which people once thought had been established have been surpassed. For example, it was once thought that organic molecules could not, by their very nature, be produced in the laboratory; but it has been done. Many nineteenth century physicists thought that a theory of atomic and subatomic particles was beyond the capacity of the human intellect; they were wrong. As recently as 1960, the eminent astronomer Fred Hoyle argued that, because of the intrinsic limits of telescopes, we had reached the end of our ability to observe distant astronomical objects and that no fundamentally new data would ever be available. It did not occur to Hoyle at that time to note that he was talking about optical telescopes; yet, while he was writing, radio telescopes were being developed and deployed, and these new observing devices have provided an impressive array of new discoveries. We have expanded our knowledge to an incredible degree in the past hundred years, and we have no idea what will be accomplished in the next thousand years. There may be limits to science, there may be limits to human knowledge, but we do not know if there are such limits or what they are. If this question can be answered at all, it can only be answered by further research. And if the history of science provides any indication as to what we should expect as a result of further research, it is that we should expect to be surprised.

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"Scientific" Creationism as a Pseudoscience

Leon H. Albert

The highly influential philosopher of science, Sir Karl Popper, in his now classic *The Logic of Scientific Discovery* (1959), focuses upon one major criterion for distinguishing between legitimate science and pseudoscience. He labels this criterion *falsifiability* and contends that any theory claiming a legitimate scientific status must be, *at least in principle*, falsifiable. That is, there must be some conceivable observation that could disprove the theory. It is most relevant to note that Popper explicitly recognizes that a legitimate scientific theory may be falsifiable *in principle* but, due to limitations of time, space, or technology, unfalsifiable *in practice*.

I think it is safe to say, in light of the extensive references to Popper's work throughout the whole spectrum of the professional literature, that for most modern scientists and philosophers of science Popper's concept of falsifiability has come to completely replace the concept of proof as the major criterion for evaluating the worth of scientific theories. It is now generally recognized that the concept of proof was improperly transferred from the domains of pure mathematics and logic, where it still retains its legitimacy, to the realm of the empirical sciences. We now realize that no legitimate scientific theory can be proven in any

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kind of absolute sense.

The reason for this is basically a logical one. Given that every theory is a product of human reason and thus potentially fallible, it therefore follows that there is *always* the possibility that someone may develop a superior theory—that is, one that explains more or one that explains better. Hence, as long as there is this logical possibility, we can never say of any existing theory that it has been proven in any absolute sense. (In fact, it is really superfluous to qualify the word *proof* with the modifier *absolute*.) Hence, when we do run across the use of the term *proof*, or some variation on it, either in the older literature or in the current writings of those few who have not been exposed to Popper's influence, we should automatically translate the language into a form consistent with this modern view. For example, the claim that some theory has been "proven" should be read to say no more than that there is "overwhelming evidence" supportive of the theory.

In light of the foregoing, it is in a very basic sense illogical or reflective of a deep ignorance of the modern philosophy of science to demand that any theory must be proven before it can be considered legitimately scientific. Yet, one of the most persistent claims to be found in the literature of "scientific" creationism is the contention that the theory of evolution is not a valid scientific theory because it has not been "scientifically proven" (*see*, for example, Morris et al. 1974:4; Wysong, 1976:44).

This contention is, incidentally, quite often framed in a vocabulary that creationists have evidently brought with them from their common grounding in fundamentalist theology. Just as nonfundamentalists are dismissed as not being "true" Christians, so, in a parallel exercise in word magic, evolutionary scientists are held to not be practicing "true" science. The briefest of analyses soon reveals that "true" Christianity and "true" science are simply Christianity and science as defined by fundamentalists and "scientific" creationists, respectively, with a total disregard for any definitions offered by nonfundamentalists and "nonscientific" creationists to the effect that "scientific" creationism enjoys some sort of scientific validity simply because a number of its advocates have earned degrees in various sciences—as if the conferring of such a degree somehow magically transforms one's religious convictions into scientific propositions (*see*, for example, Morris et al. 1974:8; Wysong, 1976:21).

Returning to Popper's concept of falsifiability and its role in the evaluation of scientific theories, it is important to note that Popper pointed out that a theory is to be judged just as much for what it predicts will *not* occur as for what it predicts *will* occur. In other words, a legitimately scientific theory not only predicts various allowable observable events but also forbids the occurrence of a whole domain of possible events. While the occurrence of one of the allowable events does not prove the theory (because the same event could have been predicted by other theories as well), the occurrence of one of the forbidden events

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does falsify it. (It should be pointed out, however, that, when confronted with one or a few such falsifying events, a theory that has *withstood numerous attempts at falsification* and which *has no serious, legitimately scientific competitor*, will still be retained, in spite of such anomalies.)

Let us now consider how "scientific" creationism on the one hand and the theory of evolution on the other stand up to the criterion of falsifiability. Here we shall see the most basic reason why "scientific" creationism is forever doomed to remain in the realm of pseudoscience.

By definition, "scientific" creationism is irrevocably grounded in an appeal to the existence and operation of an obviously omnipotent supernatural being—that is, *a being that by its very nature is capable of virtually anything.* It therefore follows that there is literally no conceivable observation that cannot be reconciled with the virtually limitless actions of such a being. "Scientific" creationism thus lacks the central defining characteristic of all modern scientific theories. It is absolutely immune to falsification. Literally any problem confronted by "scientific" creationism as it is applied to the empirical world can be resolved through an appeal to unknown and unknowable supernatural operations. And although "scientific" creationists are extremely fond of pointing out various alleged problems with the theory of evolution (problems that are more often than not the result of their own strawman conceptions of both science and evolution), they appear to remain blissfully ignorant of the fact that any legitimate scientific theory *must* generate problems. (Apparently, once again under the influence of their theology, "scientific" creationists feel that "true" science is some kind of quest for absolute certainty—a conception of science that is totally rejected by Popper.) It is extremely important to emphasize again that "scientific" creationism is not, as is the case with some legitimately scientific theories, only unfalsifiable *in practice*; it is also unfalsifiable *in principle.*

The same point can be expressed in another way. Science is concerned with explaining why the world is one way rather than some other way. The introduction of an omnipotent supernatural being into any explanation immediately precludes this possibility. As the scriptures tell us, "With God, all things are possible." This may be fine theology, but it stands in direct opposition to the central goal of all science. This is why "scientific" creationism actually acts as a brake on any valid scientific research. It is really what Gillespie characterizes as an antitheory—a void which has the function of knowledge but which conveys none (1979, p. 8).

I will illustrate this diametric difference between legitimate science and the "true" science of "scientific" creationism with an example from the field of biological anthropology.

According to the theory of evolution as it has been applied to the development of the Primate Order, the chimpanzees represent our closest living relatives. This conclusion was based upon comparative anatomy and the principle that

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similarities in form reflect evolutionary relationship. Once again, this cannot be said to be a "proof" of the postulated evolutionary relationship. Biologists can cite many instances of parallel evolution in which forms that are only distantly related have developed similarities in structure—for example, the almost identical structures of human and octopus eyes.

However, the recently developed techniques for measuring the detailed structure of the most basic molecules of life, DNA and protein molecules, have provided a potential means of falsifying the theory of evolution or at least this particular implication of that theory. Simply consider the two extremely opposed possible research results: on the one hand, it could have conceivably turned out that humans and chimpanzees were totally dissimilar in their molecular structures; on the other hand, it could have been found—as it was—that humans and chimps are practically identical in those structures. (Indeed, in the molecules so far compared, the identity has been found to be over 99 percent.) Had the former situation been found, it would have constituted a falsification of the postulated close evolutionary relationship between humans and chimpanzees. Were there to be similar discoveries throughout the whole range of postulated evolutionary relationships, this would constitute a severe, perhaps even fatal, blow to the entire evolutionary edifice. In point of fact, as now has been well established, the findings of such molecular comparisons have provided overwhelming support for the evolutionary relationships postulated initially on the basis of comparative anatomy.

Now consider the alternative responses of "scientific" creationists to these same two possibly opposing research findings. Had the molecular researchers found that human and chimpanzee DNA and protein structures were totally dissimilar, the "scientific" creationists would not have been able to contain themselves. They would have been shouting from the rooftops that this was "proof" positive of the validity of "scientific" creationism—that this finding revealed clear evidence of the creator's intention to keep distinct the "created kinds." As it is, of course, the research results were just the opposite. Now, we may safely anticipate that "scientific" creationists will be arguing that this finding, too, is just as their "model" would have predicted, that what we have here is clear evidence of the creator's grand common design. Heads I win; tails you lose.

Now, it can be appreciated why "scientific" creationists, in setting up their debates around the world, are so fond of framing those debates around some variation on the quustion: "Does evolution or creation provide a better explanation of the scientific evidence?" Invariably, the "scientific" creationists glibbly slide over the fact that scientific evidence is only scientific if it is viewed from the framework of science—a framework that, as we have seen, excludes appeals to the supernatural. Thus, in one recent presentation of the creationist position, we are informed of the "fact" that "the Creation Model fits the *real* facts of science at least as well as the Evolution Model" (Morris and Parker, 1982, xiv; emphasis

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added). Note, incidentally, the word magic implicit in the use of the qualifier *real* to imply that any "facts of science" which either do not support creationism or which do support evolution are not "real" scientific facts—the qualifier *real* is the functional equivalent of *true* in the writings of fundamentalist "scientific" creationists. Thus, "scientific" creationists consistently argue that creationism provides a better explanation than does the theory of evolution.

And in this, they are in a very limited sense absolutely correct. Given an omnipotent supernatural creator, virtually anything can be "explained" as a result of that creator's actions and desires. The problem is, of course, that such an "explanation" is not a scientific one, and it is totally dishonest to imply that it is by framing the question at issue in terms of "scientific facts." In my own debating experience with Duane Gish of the Institute for Creation Research, when I raised this issue, he neatly slithered away from the point with an observation to the effect that, whenever he came to debate scientists, he wanted to talk about scientific facts while they wanted to talk philosophy (as if the question of what constitutes a scientific fact is totally unrelated to the philosophy of science).

Considerations such as these are almost totally ignored in the writings of "scientific" creationists. Indeed, in one of those unintended ironies with which that literature abounds, Sir Karl Popper is actually cited as a scientific authority who is opposed to the theory of evolution. He was never, of course, a "scientific" creationist; he simply once had some reservations about various aspects of general evolutionary theory. Today, Popper is a full-blown evolutionist, a point conveniently and consistently ignored by those "scientific" creationists who cite his earlier statements. Indeed, when Gish, Bliss, and Bird of the ICR cite a later criticism of Popper's regarding natural selection (1981, p. i), they even suppress the full title of the book referred to. They identify it in their bibliography as *Objective Knowledge* when in fact the full title is *Objective Knowledge: An Evolutionary Approach* (1975). Also conveniently ignored is the fact that, in this very same book, Popper explicitly rejects his earlier criticisms and frames his description of the nature of science in evolutionary language. He speaks, for example, of competing theories in terms of the survival of the fittest. Unlike legitimate scientists, as Popper conceives of them, "scientific" creationists have a highly developed talent for ignoring and even denying any facts that contradict their preconceptions. Wysong, for example, pays lip service to Popper's criterion of falsifiability (1976, p. 27) and even contends that in evaluating the relative worth of creationism as opposed to the theory of evolution, "each of the propositions must be falsifiable" (1976, p. 49). Lip service having been paid, this is the last we hear of the concept of falsifiability in the remaining 406 pages of his book!

Yet, it cannot be denied that "scientific" creationists are enamored of at least the form, if not the substance, of science. One cannot escape the suspicion that if the fundamentalists who provide the overwhelming majority of "scientific" creationists were to adopt a clerical garb it would consist of a lab

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coat emblazoned with a cross.

At the same time, they are obviously committed to a set of religious dogmas that bring them into direct conflict with one of the most widely accepted theories in all of science: the theory of evolution. Thus, they find themselves in a perpetual double bind. And their attempts to resolve this double bind take the form of an effort to redefine "true" science in such a manner that it no longer conflicts with their cherished fundamentalist dogmas.

As a result, they have developed their own little "folk conception" of science, one that is totally subservient to their preconceived fundamentalist theology. *Folk conception* is a term used by cultural anthropologists to refer to the set of ideas that the people in a particular culture or subculture have about some area of reality. For example, people in different cultures have different folk conceptions of the law, of the proper form of family, of morality, and so forth. However, the folk conception of "true" science developed by "scientific" creationists has about as much resemblance to legitimate science as does astrology to astronomy or witchcraft to medicine. To a great extent it is simply and simplistically an extended exercise in two old debator's tactics: begging the question (that is, seeking to define the point at issue in such a manner so as to win the debate by definition) and the strawman argument (that is, misdefining your opponent's position in such a way as to guarantee its easy destruction) combined with liberal doses of word magic. Word magic is a typical feature of primitive closed thought systems in which it is commonly believed that words have the power to create or affect the things for which they stand (*see,* Horton, 1967).

In coming up with their definitions of "true" science, "scientific" creationists virtually never rely upon the writings of philosophers of science. At best, their definitions began as unjustified extrapolations from dictionary definitions, usually combined with out-of-context quotes gleaned from the writings of evolutionary scientists (*see*, for example, Gish, 1973, p 2; and, for particularly simple-minded definitions of science and the scientific method, Wysong, 1976, pp. 40–43).

One omnipresent characteristic of "scientific" creationists' folk definitions of science is the contention that "true" science cannot address itself to the explanation of any event that occurred before there were any scientists present to observe it (*see*, for example, Morris et al. 1974, pp. 4–5; Gish, 1973, p. 3; Wysong, 1976, p. 43; Morris and Parker, 1982, xiii). One can see the obvious fundamentalist theological motivations that underlie this particular begging of the question. In one fell swoop, by definition, evolutionary studies, historical geology, and much of astronomy are automatically excluded from the domain of legitimate science.

Before dealing with the shortcomings of this particular attempt to restrict the range of science, it is most significant to note that this tactical maneuver also automatically excludes "scientific" creationism from the realm of "true" science. Surprisingly, in an uncharacteristic display of honesty and humility, this

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is frequently openly conceded by "scientific" creationists themselves. But, this is really a form of copping a plea to a lesser offense as well as being a kind of diversionary tactic. By pretending that they are guilty of some kind of alleged scientific misdemeanor—that is, dealing with events that occurred prior to the existence of scientific witnesses—the "scientific" creationists draw attention away from their actual scientific felony: the utilization of a completely unfalsifiable appeal to the supernatural. Moreover, as we shall see, the alleged misdemeanor to which they so graciously plead gulty turns out on analysis to be no scientific crime at all. Finally, and here we see the schizophrenic element manifesting itself, this admission of a completely nonscientific status for "scientific" creationism is conveniently forgotten in their persistent use of the term *scientific creationism* in their articles, books, and, indeed, in the very name by which they identify themselves.

The contention that "true" science cannot deal with phenomena that occurred before any scientists were present to observe them is based upon two unvoiced and demonstrably false presuppositions. The first and more general false supposition is that science deals only with that which is directly observable—that is, the empirical world. At best, this is only a half-truth (even this is generous—it would probably be more legitimately characterized as an eighth-truth). Science constantly postulates the existence of theoretical forces and entities that are not directly observable. No one has ever actually seen an atom. No one has ever directly observed either electricity or gravity. To even suggest that science cannot deal with unobservables is to display an ignorance of the nature of the scientific enterprise. This is not to say that such unobservables have no relationship to that which can be observed. The legitimacy of postulated theoretical forces and entities is constantly being tested against the observable world. Such testing constitutes a way of attempting to falsify the postulated theoretical entities and forces. Such testing, so crucial to any legitimate science, is, as we have seen, impossible with respect to the omnipotent supernatural being that constitutes the central "theoretical" entity in "scientific" creationism. Indeed, if we once again turn to the writings that provide the ultimate motivation for "scientific" creationism, we are explicitly told, "Thou shall not test the Lord, thy God." Once again, this may be fine theology, but, if that same God is assigned the function of a theoretical entity in a proposed explanation, this injunction represents a prohibition against the central activity of the scientific enterprise!

The second false presupposition that underlies the creationists' restriction against "true" science saying anything about events that occurred prior to the existence of scientific witnesses is the apparent presumption that such postulated past events will have left no record of their occurrence, no evidence by which theories about that alleged occurrence can be tested. This is analogous to arguing that, because there were no actual witnesses, we can never "truly" scientifically know if the bear actually did defecate in the woods—this despite the presence of a steaming pile of bear fecal material and numerous bear footprints. Likewise, we

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would have to deny, in spite of the superabundant fossil evidence, "true" scientific legitimacy to the claim that vast numbers of now extinct species once roamed the earth, simply because there were no scientists present to directly observe them.

When confronted with such criticisms of their theologically motivated folk conception of science, "scientific" creationists commonly resort to another tactic popular among debators: *equivocation.* This is the practice of switching definitions of a key word or concept in mid-argument. By far one of the master practitioners of this art is Henry M. Morris, director of the ICR. Faced with attacks on the scientific legitimacy of "scientific" creationism, Morris invariably ignores the substance of those attacks and argues that "true" science simply means "knowledge" (Morris et al. 1974, p. 1; cf. Morris 1982, p. i; Morris and Parker, 1982, xiii). In a very restricted sense, Morris is correct. If we look up the etymology of the word *science*, we do indeed find that in the original Greek form it did mean "knowledge." The problem here is that words very often cannot be simplistically defined solely in terms of their etymology. Language itself evolves. Words, in the history of their usage, often undergo radical revisions in their accepted meanings. One would expect that a self-proclaimed biblical expert such as Morris pretends to be would be quite cognizant of this elementary fact.

In Darwin's day, for example, the word *science* referred to philosophy or knowledge derived from nonrevealed sources (Himmelfarb, 1959, p. 36). Scientists were then referred to not as *scientists* but as *natural philosophers.* To this day, teachers in the natural sciences in universities are assigned the academic rank of "professor of natural science" (even a number of "scientific" creationists claim this title—although what they advocate is anything but "natural" science). Even the dictionary, the primary source of "scientific" creationists' misconceptions of science, identifies *science* and *natural science* as synonyms of one another.

All of this is, once again, conveniently ignored when "scientific" creationists accuse scientists of begging the question in denying the mantle of science to claims which invoke the supernatural. Instead, it is held that "scientists are supposed to 'search for truth' wherever that search leads" (Morris and Parker, 1982, xiii). Totally disregarded in this hopelessly naive conception of "true" science is the fact that it would require scientists to spend innumerable hours in the consideration of multitudes of supernaturalistic "explanations" that are intrinsically unfalsifiable. Furthermore, if we were to accept the equation of *science* with *knowledge*, then every field of knowledge, from stamp collecting to polishing shoes, would have to be considered a legitimate science.

The issue of the proper definition of what constitutes legitimate science, as well as many other issues in the evolution-creation controversy, boils down in many ways to an argument over proper authority. Confronted with the undeniable fact that the overwhelming majority of scientists in general, and certainly practically all life scientists, do accept the scientific legitimacy of the theory of

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evolution, "scientific" creationists frequently include in their folk definitions of science the claim that scientific truths are not established through some kind of majority rule or popular vote (*see*, for example, Wysong, 1976, pp. 20–21). In this claim, they are, as usual, wrong.

If students of the nature of science are in agreement on anything, it is that science is a communal activity. The individual scientist may indeed formulate a particular theory explaining some phenomenon. But that explanation does not really enter the domain of science until it has been scrutinized, criticized, and tested by his or her colleagues in the relevant discipline. And, when the colleagues in a particular scientific discipline are in well-nigh complete agreement on the validity of some given explanation, it comes close to a form of scientific lunacy to proclaim the learned majority opinion wrong and to advocate some explanation that they emphatically reject.

This is not to say that the majority is always right. As "scientific" creationists and advocates of other pseudoscientific explanations never tire of pointing out, there have been a number of explanations that at one time have been rejected by the scientific community only to have later been demonstrated to be valid. Invariably ignored by those who make this argument is the fact that the number of such cases is miniscule compared to the number of cases in which the original negative judgment of the scientific community was subsequently and totally corroborated. Indeed, in the twisted logic of this sort of argument, it would seem that the truth value of any idea increases with the degrees to which it is rejected by the scientific community! It is also revealing to note that, in their own fundamentalist educational institutions and in direct contrast to the accepted practice in science, such minority or dissenting opinions are allowed no expression whatsoever.

It is difficult to imagine any alternative to a kind of majority rule by experts in the evaluation of the worth of scientific ideas. What better guideline can there be than to at least tentatively accept the authority of a body of experts on any given subject matter? If I go to a thousand auto mechanics and 999 of them tell me I have a cracked engine block while one, who claims to be in contact with aliens from another universe, contends that my problems flow from my having offended Sydney the avoacado spirit, whom am I to believe? In a parallel manner, if we follow the lead of the "scientific" creationists regarding their confrontation with evolutionary scientists, I am to reject the authority of the entire scientific community and to accept the claims of a group who openly admit that their ultimate commitment is not to a *quest for the truth* but to the *propagation of an alleged truth already divinely revealed.*

Consider the words of Henry Morris on the question of the historicity of the universal flood as it relates to geology:

> But the main reason for insisting on the universal Flood as a fact of history and as the primary vehicle for geological interpretation is that

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> God's Word plainly teaches it! *No geological difficulties, real or imagined*, can be allowed to take precedence over the clear statements and necessary inferences of Scripture. [1970, p. 33; emphasis added]

It would be difficult to formulate a statement that could stand in greater opposition to the central spirit of modern science.

But this same Henry Morris actually had the gall, several years ago, to stand at the pulpit of Jerry Falwell's church, after having been introduced as "Mr. Creationism," and proclaim that the media were misrepresenting the conflict between "scientific" creationism and evolution as a conflict between religion and science. The congregation, instead of falling out of their pews with laughter at the blatant incongruity of such a statement in such a context, sat there piously nodding their approval.

Comedian George Carlin has observed that there are some words that just don't seem to go together. He gives as examples the terms *jumbo shrimp* and *military intelligence*. I think that there can be little doubt that the top honors for such contradictions-in-terms should go to *scientific creationism*.

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Science, Nonscience, and Neither

Michael Alan Park

Those of us concerned with the multifaceted threat of creationism, as well as other ideas of that nature, need to make clear to the public that both the sciences and the nonsciences (including religion) are two legitimate areas of knowledge. Each of these, working in harmony with the other, is vital for the operation of any society. Pseudoscience, on the other hand, is a confusion of these two areas and, as often as not, involves a conscious attempt to convey that confusion to others.

Science, of course, should need no introduction to us. Its definition is a basis for all our arguments against creationist claims. As Ronald H. Pine so nicely pointed out, science is a "game"—a set of rules governing a certain process (1984). If you play by the rules, you're doing science; otherwise, you're not. By this standard, then, a biologist is a scientist; but a physician, though he or she uses scientific knowledge, is not.

I would like, however, to expand and loosen up the meaning of science a little and consider it not only a strict set of rules for a specific procedure but also as a *sphere of human knowledge.* Thus, both the biologist and the physician are involved in the interaction with scientific knowledge—that is, knowlege which has been acquired and tested using the scientific method—the rules of the game. Science then becomes the concrete knowledge we possess and use about the world in which we live.

Moreover, the basics of the scientific method are applied all the time outside of the realm of science as we usually conceive of it. The physician, for example, must articulate a problem (say, a person with an odd set of symptoms) and then generate hypotheses (in this case, possible diseases to explain the observed symptoms). Each hypothesis (diagnosis) is tested until one fits all the observed data, fulfills certain predictions, and is supported by additional data. Then it is acted

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upon. One does the same sort of thing when attempting to solve a financial problem. Thus expanded, scientific knowledge involves any ideas about the world which are based on inductive reasoning and which are open to testing and change.

Nonscience is the other sphere of human knowledge. It involves religions, ethical beliefs, moral precepts, and philosophical ideals. (Unfortunately, the "non" in *nonscience* almost implies some value judgment, but there doesn't seem to be a better term.) These kinds of knowledge also answer for us questions about the world, but, unlike scientific answers, these answers are based upon faith; they are taken for granted and they are not open to testing. They can be questioned and sometimes changed, but, when they are, it is not through any sort of inductive reasoning or experimentation. It is through abstract, philosophical analysis.

Nonscientific ideas show us how to use scientific knowledge. They tell us what our relationship is with the world around us and with each other. They answer questions which need answering but for which we have no scientific answers.

We must take note, however, that societies differ greatly in terms of just what sorts of things fall into each of these categories. Let us not be fooled into thinking that there are absolutes. For instance, the Fore people of New Guinea (famous for their unique disease *kuru* and for the cannibalism which transmitted it) consider all diseases and ailments to be the results of sorcery. It is an idea taken on faith, for no matter how successful or failed their attempts may be to counteract sorcery they still hold to that notion. Their scientific knowledge simply does not, or cannot, apply to disease. It's not that they don't have science; they do. Their agriculture, shelter building, and tool technology all involve reasoning and knowledge which we would have to consider scientific—at least under my expanded definition.

Our society, on the other hand, explains disease scientifically. But we are not without nonscientific ideas. The idea that all our citizens deserve the benefit of medical science is a nonscientific idea—it cannot be tested. Therefore, it can't be proved or disproved. It is taken on faith and is part of the larger religious-ethical concept about "do unto others . . ." which is the basis for our legal system.

So, for any society, though the content and form of each realm of knowledge may differ, both science and nonscience are vital. Every society needs a body of scientific knowledge through which to understand at least those aspects of the world directly relevant to its basic survival: how to get food, seek shelter, manufacture tools, and so on. But each society also needs rules that will govern the interactions of its people—with each other and with the world around them. The whole board in the game of life must be covered; all the questions must be answered and all the moves regulated—if not by science, then by nonscience.

Because of this, one realm cannot absolutely argue against the other. One cannot be set in opposition to the other with the goal of one taking precedence. To be sure, conflicts have always arisen. If they didn't, cultures would never

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change. But the resolution of such conflicts is not the victory of one sort of knowledge over the other but the reestablishment of a harmonious relationship, most likely by re-arranging the organization of the contents of each type of knowledge—that is, of those aspects of the world each speaks for and explains.

For instance, the current debate in this country over abortion will not be "won" by the practical reasons for the practice nor by some philosophical ethic concerned with freedom-of-choice nor by a formal religious belief which considers abortion to be murder. Rather, the issue will be resolved, if it is resolved at all, by the evolution of a collective cultural "decision" on the matter. This decision will end up fitting into one of the spheres of knowledge and thus come under its purview. It may be that abortion will become "normal," entirely legal, and morally acceptable (though not universally practiced or liked) simply because the practical reasons for it become so pervasive that the practice increases to the point of being part of the cultural system. Or the moral compunctions against it may become so strong and widespread that other solutions are found to the practical problems which led to the practice in the first place, and it will become needed only in rare circumstances. Whatever happens will involve not a victory but a realignment of how our culture operates in terms of the interactions of scientific and nonscientific knowledge.

Pseudoscience is another matter altogether and is the real problem at issue here, for it confuses these other two areas of knowledge and endeavor and, in doing so, brings them into forced conflict with each other. Both are harmed in the process. Pseudosciences have the following characteristics:

1. They involve ideas which are actually testable statements about the natural world. The stars foretell the future; ancient astronauts built the pyramids; you can bend metal with your mind; all life was created simultaneously. These are all statements which are perfectly open to testing using the rigorous methods we know of as science. However,
2. Proponents of pseudoscientific ideas are not about to subject their ideas to testing or to anything that vaguely resembles science (titles such as "scientific creationism" notwithstanding). And this is because,
3. They treat the ideas as nonscientific beliefs are treated—that is, as matters of faith. Thus, the ideas are unchanging. New data are manipulated to support the ideas rather than used to test them.
4. (And this is where the confusion really exists.) The ideas are often connected to or dependent upon some legitimate nonscientific concept. This is clearly the case with "scientific creationism," based as it is on a fundamentalist literal interpretation of Genesis. And, as Robert Schadewald points out (1981–1982), it is also true of such things as a belief in a flat Earth (which finds its basis in biblical passages such as Matthew 4:8, which tells how the devil takes Jesus to the top of a high mountain so that he can see "all the kingdoms of the world."

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So, it is the pseudosciences against which we are arguing—not the nonsciences—and it is the conscious confusing of these two by pseudoscientists that is one of the biggest threats to rational thought. But there is still one more distinction to be made in order to avoid misinterpretation. We must look at *motive.*

As I said, in our culture we view the treatment of disease in a scientific fashion. Any ideas about disease akin to those of the Fore would have to be considered by us to be pseudoscientific. The Fore would be attempting to answer questions about natural phenomena through nontestable, unchanging, a priori beliefs taken on faith. But not everyone who believes such ideas, even within this society, can be considered a pseudoscientist with the conscious motives that the name implies.

There are, for example, "faith healers" who are little more than charlatans. But there are at the same time many for whom nonscientific answers to questions of disease fall entirely and logically under the nonscience realm of knowledge. For them there is no conscious effort to confuse anyone else, no ulterior motives behind the expression of their beliefs. The problem here is simply that, for such people, their categories of knowledge are not aligned and organized in accord with those of their society as a whole. While we may be inclined to try to "educate" such people, we should not treat them as we do those who *do* have ulterior motives. Indeed, believers in such ideas are often the victims of proselytized confusion. And such confusion certainly was the case with most of those at my 1982 debate with Duane Gish who shouted "Amen!" after each of his "scientific" points.

We must, then, be careful to fight only those who deserve it, while, at the same time, try to impart knowledge to those who, out of ignorance or vulnerability, have succumbed to pseudoscientific nonsense. And one way to assist us in both these endeavors is to keep clear the distinctions between the two legitimate and the one illegitimate spheres of human knowledge and to understand that, at the hands of the latter, both of the former suffer—to the detriment of society itself.

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The Evolution-Creation Controversy: Subtle Bias in the Press

Michael Zimmerman

Now that the United States Supreme Court has agreed to review the Louisiana law promoting equal time for evolution and creation, it's a pretty good bet that bits and pieces of the evolution-creation controversy are going to be aired in the press. It is also a pretty good bet that the coverage is going to be less than superb. I feel that it is important that explicit misstatements be corrected whenever they occur. It is also incumbent upon all of us to attempt to correct the more subtle, often unstated, assumptions that these articles are likely to make.

Let me demonstrate some of the substantial bias (although probably unintended) that can make its way into news reports with the example of a short piece published in the *Cleveland Plain Dealer* on May 6, 1986. The article was an Associated Press story out of Washington, D.C., and was simply meant to report that the Supreme Court had decided to review the federal appeals court ruling in the Louisiana equal time case. The 280-word article included at least four annoying points. The headline, "Top Court will Decide New 'Monkey Law' Case," cannot help but arouse interest. I do not feel, however, that the type of interest aroused will be very helpful in promoting a high level of intellectual discussion on the topic.

The next two examples of bias are more significant and come from a single sentence. In a paragraph briefly summarizing the basics of "creation science," the articles states: "Although it is consistent with religious views, it does not rely overtly on the biblical book of Genesis." By beginning with the phrase, "Although it is consistent with religious views," the sentence in question makes the unstated assumption that evolutionary theory is inconsistent with such views. Indeed, in the following paragraph where evolution is briefly outlined, no mention is made of the fact that evolutionary theory is also consistent with many people's religious views. Nor is it mentioned that many of the plaintiffs in both the

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Arkansas and Louisiana cases were religious figures representing most of the major faiths. Instead, the public is left to infer that "creation science" is both scientific and compatible with religion while evolutionary theory is in direct opposition to all religious teachings.

Second, whether "creation science" is too closely entangled with the Bible or with one fundamentalist religious sect is exactly what the Louisiana case is all about. Whether intended or not, the AP is apparently passing judgment on the constitutionality of the case and, in fact, is directly contradicting the decision reached in the very similar Arkansas trial in this regard. Judge William Overton's January 1982 decision ruling that the Arkansas equal-time law was an unconstitutional infringement of the establishment clause of the First Amendment was quite explicit:

> The evidence establishes that the definition of "creation science" has as its unmentioned reference the first eleven chapters of the Book of Genesis. Among the many creation epics in human history, the account of sudden creation from nothing, or *creatio ex nihilo*, and subsequent destruction of the world by flood is unique to Genesis. The concepts . . . are the literal Fundamentalists' view of Genesis. [It] is unquestionably a statement of religion.

By not attributing the statement that "[creation science] does not rely overtly on the biblical book of Genesis" to any particular person and by instead treating it as established fact, the AP is clearly misleading the large majority of people who read their account.

Finally, the article quotes two experts on the issue: Wendell R. Bird and Anthony T. Podesta. Bird is described as an Atlanta lawyer and the chief legal advocate for the "creation science" movement, while Podesta is portrayed as being the president of the liberal advocacy group, People for the American Way. These descriptions set the stage quite clearly, even if erroneously. The evolution versus creation controversy can thus be seen as one portion of the larger battle between liberals and conservatives. Although People for the American Way may have a liberal image, I do not understand why an organization that works to protect the First Amendment should be identified by the AP as either liberal or conservative. In fact, People for the American Way itself makes no claim to represent only a portion of the political spectrum. In the context of the article in question, moreover, I cannot fathom what important information is transmitted to readers by labeling Podesta as either liberal or conservative. Podesta is simply an outspoken defender of the First Amendment. Surprisingly, no mention of the First Amendment was even made in the AP article. It is also somewhat curious that Bird's affiliation with the Institute for Creation Research was not mentioned. This seems to be a particularly relevant point given that the ICR is the

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research arm of Christian Heritage College and that faculty, at the time of their appointment and annually thereafter, have to swear that they agree with the following statement:

> We believe in the absolute integrity of Holy Scripture and its plenary verbal inspiration by the Holy Spirit as originally written by men prepared for God for this purpose. The scriptures, both Old and New Testaments, are inerrant in relation to any subject with which they deal, and are to be accepted in their natural and intended sense . . . all things in the universe were created and made by God in the six days of special creation described in Genesis. The creationist account is accepted as factual, historical and perspicuous and is thus fundamental in the understanding of every fact and phenomenon in the created universe.

What can be done? Clearly an educated and fully informed public is the best ally that evolutionary scientists can have. It is thus imperative to correct such misuses of language when they occur. Articles such as the one described should not go unquestioned. Letters to the editor should be sent immediately to the newspaper in which the article appeared and, in the case of wire service reports, critiques should be sent directly to the headquarters of the service.

In the present case, I wrote a letter to the *Cleveland Plain Dealer* and, because of it, was asked to participate on a radio talk show in Cleveland. I have also sent a copy of this essay to Mr. Louis D. Boccardi, president and general manager of the Associated Press. Quite simply, no opportunity should be missed to correct popular misconceptions about the nature of this debate.

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Inadvertent Support of Evolution by Its Opponents

Thomas H. Jukes

Mel and Norma Gabler are continuing their criticisms of evolution in hearings on evolution in Texas public schools. They now propose that "minimal changes necessary in science/biology textbooks" should "acknowledge incongruities between anatomical and molecular homologies" and that "one relational tree often lacks predictive value for the other. Molecularly, crocodiles group more closely with chickens. . . ."

It has long been familiar to paleontologists that birds diverged early from primitive reptiles. This conclusion is based upon the fossil record and upon anatomical homologies. For example, Romer lists anatomical similarities in "the dinosaurs, pterosaurs, and crocodiles—and in the primitive birds (which seem clearly derivable from the archosaurs)" (1966).

The anatomical and fossil evidence therefore actually *leads* to a prediction of molecular homology between birds and crocodiles and, perhaps, other primitive reptiles. A telephone call to the Gablers' office by Dr. Martin Meltz of the University of Texas at San Antonio produced a response that their statement referred to α-hemoglobin sequence homologies. These have been discussed by Dr. Max Perutz, whose research with hemoglobin contributed so greatly to the beginnings of the science of molecular evolution and who was awarded the Nobel Prize in 1962 for this research, together with Sir John Kendrew, whose studies were on myoglobin. The Gablers find themselves in distinguished company. Unfortunately, they are out of step.

Some years earlier, Holmquist and I compared amino acid sequences of cytochromes *c* for birds, rattlesnakes, and turtles. The turtle is anatomically more "primitive" than snakes and closer to crocodilians than to snakes in many respects. The divergences are shown in TABLE I. We concluded that the evolutionary rate of change of vertebrate cytochrome *c* is species-dependent as well as time-

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TABLE I

Percentage Differences in Amino Acid Sequences of Cytochromes *c* and α-Hemoglobins

(Condensed from Jukes and Holmquist, 1972; and Perutz et al. 1981)

Species Compared	Average of Percentage Differences	
	Cytochromes c	*α-Hemoglobins*
Birds : turtles	7.5	
Chicken : crocodilians		47
Birds : rattlesnakes	18.0	
Chicken : viper		57
Turtle : rattlesnake	21.0	
Crocodilians : viper		64

dependent. The results with cytochrome *c* parallel those with α-hemoglobin. Birds are related more closely to the primitive turtle than to snakes. Snakes have evolved more rapidly than turtles.

Perutz and coworkers compared α-hemoglobin amino acid sequences in three crocodilians (caiman, Mississippi alligator, and Nile crocodile) with those of other species, including chicken and viper (1981). They found that "crocodilian sequences are most similar to those of the birds, consistent with fossil evidence suggesting that birds arose from archosaurian reptiles" and that the number of amino acid differences between crocodilians and viper (lepedosaur reptile) "are much larger than between the crocodilians and the birds." These results are in TABLE I. Perutz and colleagues point out that the results support the conclusions of Romero-Herrera et al., based upon myoglobin, that the "rates of change differ in different branches of the phylogenetic tree."

Contrary to the Gablers, molecular and anatomical homologies correspond and are mutually predictive. A summary of the above findings could well be included in science biology textbooks in support of evolutionary theory.

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More on Population Growth and Creationism

James S. Monroe

David Milne's article in *Creation/Evolution* on the creationist population growth argument was a pleasure to read (1984). Surely this is one of the most absurd items in the creationists' arsenal. As Milne pointed out, it is based upon totally unwarranted assumptions, and the implications of population equations formulated by creationists are ridiculous. Milne has shown just how ridiculous by calculating the 2500 BCE population, and so forth, but perhaps it would be useful to look at some more implications of the population growth argument.

In *Scientific Creationism*, Morris introduces the population equation, $2c^n$, in which 2c is the average number of children per family and n is the number of forty-year generations since the flood (four thousand years ago). He equates this equation with the 1974 world population,

$$2c^n = 3.5 \times 10^9$$

assumes one hundred generations, and then calculates the value of 2c:

$$2c = 2\left(\frac{3.5 \times 10^9}{2}\right)^{1/100} = 2.46$$

The value of 2c should be 2.474346. This may seem like nit-picking, but if Morris' value is used the calculated 1974 population figure is nearly 45 percent too low.

The above is a prediction equation. If it has any validity whatsoever, it should predict ancient populations with at least a fair degree of accuracy. It does not. Assuming that creationists still think that this equation is valid, it is reasonable to assume that it is equally applicable to the pre-flood population. All that is needed is an estimate of children per pre-flood family, the time from creation to

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the flood, and the duration of each generation. Morris furnishes the needed data.

Whitcomb and Morris estimate conservatively that pre-flood families had six children ($c = 3$) and that generations averaged ninety years (1961, pp. 25–26). Morris claims the decay of the magnetic field gives an "outside limit" of ten thousand years for the age of Earth (1974, p. 158). The oldest reported date of the flood is sixty-three-hundred years ago (Morris, undated). Therefore, the population at the time of the flood must have been at least:

$$2(3)^{41} = 7.2946 \times 10^{19}$$

If one cares to work out the population density, it comes out to be over thirteen thousand persons per square foot for the entire earth's surface, or about 0.01 square inch per person. If the flood occurred only four thousand years ago, as suggested in *Scientific Creationism*, the mass of humanity at that time would have exceeded the mass of the earth.

It is interesting to examine this figure of 7.2946×10^{19} persons in view of Morris' assertion that the human fossil record for evolution is incredibly deficient (1974, p. 169). Since, according to creationist calculations, at least "3000 billion people would have lived and died . . . in the past million years," if evolution is true, there should be far more evidence in the fossil record. Yet the pre-flood population must have been over 24 billion times as great, and we are offered only "Paluxy man," Carboniferous "human footprints," and a few others as evidence of this mass of humanity.

Why anyone would even present population growth as a viable argument is difficult to understand. Surely those who formulated these equations were aware of the ridiculous implications. Imagine such an argument being presented in a high school science class. A good student would see through the facade of underlying assumptions in a minute. Those not so mathematically adept would be bamboozled by a completely fallacious argument. How would a teacher respond to a student's observation that these equations indicate that there were eighty-six persons in the entire world in 1300 BC, the time of the exodus, or 354 persons to witness the judgment at Babel? In short, the teacher would be in the position of defending a worthless argument.

Morris himself implies that his calculations are of little value:

> Every process in nature operates at a rate which is influenced by a number of different factors. If any one of these factors change, the process rate changes. Rates are at best only statistical averages, not deterministic constants. [1974, p. 139]

Admittedly, Morris is criticizing radiometric dating, but he is using the process rate of population growth and its accumulative effect as a geochronometer of

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sorts. He continues:

> Thus, at best, apparent ages determined by means of any physical process are educated guesses and may well be completely unrelated to the true ages. [p. 139]

I submit that Morris' calculated date of the flood is not even an educated guess. He has used completely worthless equations to calculate the age of a non-existent event. Such is the nature of "scientific" creationism.

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At this time, the special issues on Noah's ark (issue XI) and the Texas footprints (issue XIV) as well as the article "Misquoted Scientists Respond" (issue VI) are available in microfiche: respectively, numbers 265 058; 265 059; and 265 057. Each is seventy-five cents plus postage. Contact: Document Reproduction Service, 3900 Wheeler Avenue, Alexandria, VA 22304-5110; (800) 227-3742. Presumably, additional articles will be included in the future. Back issues, or "hard copy," remain available from *Creation/Evolution*, 7 Harwood Drive, P.O. Box 146, Amherst, NY 14226-0146; (716) 839-5080.

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Letters to the Editor

Professor Barbara Hargrove raises valuable points in her article in *Creation/Evolution* XVII, not the least of which is the fact that doctrinaire "scientific creationists" represent a minority, theologically as well as scientifically. However, she may underestimate the political potency of a minority movement, and I believe she mistakenly omits mention of related analyses—most prominently the work of sociologist Dorothy Nelkin (which in many ways agrees with Hargrove's thesis), anthropologist Alice Kehoe, and others. Hargrove's emphasis upon an ideological explanation of the causes of cultural change may be correct, but she should have noted more materialistic viewpoints such as sociologist Ron Roberts' 1978 *Social Problems: Human Possibilities*, anthropologist Marvin Harris' 1968 *Rise of Anthropological Theory*, and others. Why do people choose particular ideas from the menu?

I also question the extent to which she and many others assume that members of particular churches or movements share the same ideas and motives, notwithstanding public position papers. My own research suggests that many people who identify themselves as "creationists" or supporters of the Moral Majority do not share the ideology or behavior their labels imply.

If social movements have material, real-world causes, as Hargrove, in fact, hints, analyses of these causes, not just their symptoms, would seem to be in order. Ideology affects behavior, sometimes overwhelmingly. But I would ask in any case: what material factors are relevant? Are there material-world explanations of or contributions to analyses of behavior and belief systems? Is "belief" explainable as simply "mentalistic," as the author suggests?

John R. Cole

On page thirty-four of *Creation/Evolution* XVII, Dr. Barbara Hargrove says: "Even as we come to understand . . . that much of the way we comprehend our religion comes out of our experience in society, so we have come to understand that our science is also conditioned by culture."

I believe Hargrove has greatly overstated the case. It is true that science, practiced by humans as it is, is

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to some extent affected by cultural influences. But to what extent? In what ways? Caused by what kinds of influence? One cannot wave one's hands over all of science and declare that science is culturally conditioned. One must deal with the details of any specific case. There are only certain aspects of science that are conditioned by culture, and the main tool of science, the test, is not one of them.

The supreme arbiter in science is the test. (In fact, if it can't be tested, it's not science.) Cultural influences can be taken into consideration when we are looking at the sources of inspiration for ideas. Social views can also influence the kinds of tests chosen for ideas to undergo. However, only the results of tests are the measure of an idea. Moreover, those who perform tests describe what was done so that interested (and qualified and funded) individuals can repeat the test and verify (or discredit) the results. What makes science so different from other kinds of human endeavor is that, collectively, conscious effort is maintained to try to eradicate extraneous influences (such as cultural bias) on the acceptance or rejection of an idea.

Another criticism I have with a statement in Hargrove's article concerns a confusion I have seen in many other articles of a similar nature. There *are* scientists who are dogmatic. And theologians are dogmatic. But care must be taken to distinguish between these two different kinds of dogmatism.

The certainty of a scientist concerning a particular idea may grow to such a high degree that he or she is willing to say that this is *the way things are*. We may dispute that the available evidence conveys such a high degree of certainty, but we can at least discuss the evidence upon which the idea is based. We can look at the results of the crucial observations that have been made and marvel at the lack of disconfirming evidence. We might still feel that not enough information is in for a person to be so certain about the accuracy of the idea. It's a judgment call, but at least we have something to judge. We can understand what a particular scientist's certainty is based upon.

The same cannot be said for the certainty of the theologian. The theologian's certainty is built on *faith*, and thus no rational determination can be made of the evidence underlying the idea in question.

A scientist's dogmatism and a theologian's dogmatism are two very different things.

I also have a criticism concerning Hubert Yockey's statements on page forty-five: "No . . . child should be told . . . that God plays dice with the world and that he or she is only a chance configuration of atoms. If all life is only material, then the crimes of Hitler, Stalin, and Mao Tse-tung are of no consequence. If humans are only matter, it is no worse to burn a ton of humans than to burn a ton of coal."

Is it reasonable to reject an idea on the basis of disliking its conse-

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quences? No way! Our desires do not a valid test make.

But, in this case, *P* does not imply *Q*. Yockey (not unlike the creationists he criticizes) tries to play upon our hearts with this "of no consequence" idea. What does he mean by consequence? Of consequence to whom or what?

Whether or not life is only material is immaterial. Even if a human is only "matter in motion," the consequences of her or his actions remain the same. This is because an action is of consequence in direct correlation with the way in which it affects other humans, nothing more and nothing less.

Steve Heiden

In issue XVII of *Creation/Evolution*, the authors of two separate articles, both apparently attempting to promote a "moderate" position, characterize those of us who would try to understand evolution as a completely natural material process as divisive and old fashioned.

One author, religious sociologist Barbara Hargrove, says that the more "sophisticated" religious person, as well as scientists "who take seriously the prevalence of the principle of indeterminacy," are now able to "view evolution as a description of the activity of a creator God and to claim this to be an expansion of our understanding of divine greatness. . . ." The other author, information theorist Hubert Yockey, believes that he has shown statistically that the origin of living complexity cannot be ascribed to either "random" or "self-organizing" forces.

Professor Hargrove's case for the acceptance of the "guided evolution" theory is not completely argued in her article but appears to be based in some way on quantum physics. I must protest that I know of no way that quantum indeterminacy may be used as a justification for abandoning the materialist hypothesis. Arguments have been made to this effect, but these most frequently involve a confusion of modern natural materialism with "naive" Newtonian realism.

Professor Yockey's arguments are directed against particular evolutionary scenarios and require specific postulates which may or may not be valid. In any case, his arguments against self-organization, here and in other articles, do not address the question of organization driven by entropic forces in far-from-equilibrium systems. While his arguments are of some value in narrowing the range of acceptable evolutionary scenarios, they do nothing to threaten the basic materialist hypothesis which must be the starting point of any scientific investigation.

While some fruitful exchange of views might be possible concerning these substantive points, both authors go on to make moral arguments for the abandonment of materialism which are, or could be construed to be, grossly insulting to those of us who hold materialistic beliefs.

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Hargrove fears that a response to creationists "that insists on a totally secular definition of the nature of the universe and of human life, that demands a definition of human freedom indistinguishable from irresponsible, socially destructive behavior, may push the great majority of moderate Christians and others in the direction of the creationists who are now considered extremist zealots." Yockey holds that public school children should not be "told that God plays dice with the world and that he or she is only a chance configuration of atoms. If all life is only material, then the crimes of Hitler, Stalin, and Mao Tse-tung are of no consequence. If humans are only matter, it is no worse to burn a ton of humans than to burn a ton of coal."

The implication in the statements of both authors is that secularism and materialsim can provide no source of responsible ethics and must be rejected on moral grounds. Such a charge is patently false and has no place in a scientific or any other civilized form of dispute. The dogmatic claim that only supernatural forces can civilize humanity and that human thought cannot be the source of ethics and morality is a superstition which has served to blind humanity to the fact that we must be responsible not only to but *for* our morals and ethics. . . .

The burning of a ton of humans or a ton of coal may indeed make little difference to the universe exclusive of humanity. The moral content of such an event will strongly depend upon whether the observing moralist identifies more with the humans or with the coal. Only when we honestly recognize the human intellect as the source of all the moral (and immoral) judgments and pronouncements that we know of will we begin to recognize the unique value of humanity. Only then can we perhaps learn to accept responsibility for *all* of our actions.

Norman F. Hall

In response to Paul Joslin's critique (*Creation/Evolution XVI*) of my article proposing a scientific basis of a creationist view of origins, it should be noted that the article implies none of the five false inferences he draws. They are all "straw men," and I am sure his class could have fun knocking them down. The argument behind the Mount Rushmore analogy is simply this:

1. Observation shows that there is a constant conjunction between an intelligent cause and specified complexity.

2. A valid scientific analysis is based upon constant conjunction (Hume).

3. The faces on Mount Rushmore (and a DNA) both manifest specified complexity.

4. Therefore, it is reasonable to assume that there was a primary, intelligent cause for the first DNA.

All that evolutionists need to ground a plausible argument for a secondary naturalistic explanation of the origin of life is to show a constant

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conjunction between purely natural (nonintelligent) secondary causes and specified complexity such as is found in a DNA. Thus, the real debate is between those who believe the evidence points to a primary (intelligent) cause of origins (for example, creationists) and those who believe in a secondary (natural) cause of origins. It is neither here nor there whether some creator (primary cause) set up these secondary causes (as in theistic evolution). The question is whether secondary causes alone, without the direct intervention of a creative intelligence, can *regularly* (constant conjunction) produce specified complexity such as is found in Mount Rushmore or in a DNA.

In response to Paul Ricci (also issue XVI), I would note several things. First, he actually agreed with our main premise about constant conjunction when he wrote: "That Mount Rushmore was designed is clear from our past experience [of constant conjunction] with sculpted material [by an intelligent sculptor]."

Second, he fails to see that this same Humean principle of constant conjunction argues for an intelligent cause of the specified complexity in DNA. In this connection, Ricci wrongly assumes that we argue that an intelligent cause can be inferred from all information systems. We only suggest that specified complexity (of information) has an intelligent cause. Thus, he fails to recognize the difference between the simple redundant information in a crystal or a snowflake (where the same simple message is repeated over and over) and the specified complexity in a DNA.

As Leslie Orgel put it, "Living organisms are distinguished by their specified complexity. Crystals . . . fail to qualify as living because they lack complexity; random mixtures of polymers fail to qualify because they lack specificity" (*Origin of Life*, 1973, p. 189). But constant conjunction indicates that intelligence is the regular cause of specified complexity. Therefore, since a scientific analysis is based upon constant conjunction, there is a scientific basis for positing an intelligent cause of the first DNA.

In order to give similar scientific plausibility to the argument for a purely natural (secondary) cause of the origin of DNA, all that is necessary is to show constant conjunction between purely natural (nonintelligent) secondary cause and complex information, such as is found on Mount Rushmore or in a DNA.

Further, to refer to the creationist's argument as "anthropocentric" or a "linguistic necessity" is like arguing that Mount Rushmore did not have an intelligent cause because it would be anthropomorphic to assume such a cause, and it is only the necessities of language which lead us to say that this sculpture must have had a sculptor. But this is obviously not a valid response in either case.

Raising the question of whether this intelligent cause is material or nonmaterial is actually immaterial to the argument we gave. However intelligence is defined, it is reasonable

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to posit it as the cause of specified complexity.

Further, the intelligent cause of first life does not have to be identical to human intelligence any more than a message from an extraterrestrial on the SETI radio telescope proves an intelligent being *identical* to humans exists in outer space. The principle of uniformity (analogy) only calls for a like cause for like events in the past. For in the strict sense, no two events are identical. Hence, no two causes need be identical, only similar.

As to whether the cause of origins is natural or supernatural, a tip might be gained from the Big Bang theory which gives evidence that the whole material universe came into existence some billions of years ago. As agnostic Robert Jastrow put it (*Christianity Today*, August 6, 1982):

> Astronomers now find they have painted themselves into a corner because they have proven, by their own methods, that the world began abruptly in an act of creation to which you can trace the seeds of every star, every planet, every living thing in this cosmos and on the earth. . . . [p.15]
>
> . . . that there are what I or anyone would call supernatural forces at work is now, I think, a scientifically proven fact. [p.18]

For if the whole material (natural) universe came into existence, then it is not unreasonable to posit a supernatural cause for it. Indeed, since such a cause is beyond the natural (that is, material) world, it would by definition be a supernatural cause. So in view of Big Bang or Information Theory applied to DNA (a la Yockey), it is scientifically plausible to speak of a nonmaterial, intelligent cause of the universe and of first life. This would mean that the scientific evidence (based in constant conjunction) points to a nonmaterial, nonnatural, intelligent cause of the whole physical universe and first life. This, I suggest, is a scientific basis for a creationist perspective. Since such a primary (intelligent) cause view is logically possible, has historic precedent among early scientists, is held by many scientists today, and is based in the scientific principle of uniformity (constant conjunction), it is difficult to justify its exclusion from scientific speculation about origins.

Norman L. Geisler

The recent battle in *Creation/Evolution* about the theological argument from design has missed a few major and important points.

To begin with, the creationist argument from design is related to the classical argument in name only. If a rational design is to be seen anywhere, it must be in the fundamental framework of physical laws rather than in the complex interactions of physical systems. One is much more likely to see design in say, the rules of chess rather than in the complex in-

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teractions that go on during an actual game. Thus, a modern theologian pursuing the design argument according to the classical tradition should appeal to the symmetry relations among fundamental particles, the mathematical elegance of physical laws, and so on. For example, the fact that the exponent in the formula for gravitational and electrical attraction is -2 rather than something else permits an astounding degree of mathematical simplification that would not otherwise be possible.

I personally consider arguments of this sort to be the most compelling objective argument for the existence of rational design in nature, even if the argument is in some disfavor among the theologians. Given some of the things I *have* seen theologians endorse recently, I do not consider the lack of theological esteem for the argument from design to be a very cogent argument against it. Something very like the argument from design, though without the external designer, is embodied in the strong anthropic principle in cosmology.

We see few creationists dealing with the fundamental symmetries of nature. Instead, their argument from design rests primarily on the complexities of biological systems. The reason is clear: finding design at this level appears to support belief in the creation of life *ex nihilo*, whereas symmetry relations among fundamental particles do not. In fact, if we get too embroiled in the beauties of physical laws, we might even find that they are capable of accounting for the origin of life. Horrors!

But to make their version of the argument from design work, creationists have to be very selective in their use of data—ignoring, denying, or rationalizing biological structures that fail to fit their concept of design. There are, for example, structures that seem to be *ad hoc* modifications of whatever pre-existing feature was handy, such as Stephen Jay Gould's celebrated Panda's thumb. There are vestigial organs which creationists usually rationalize by finding some marginal function for them. And there are gross deviations from rational design, like birth defects, which creationists usually ascribe to the aftereffects of The Fall. Finally, there are behavioral traits that simply fail to square with the creationist image of the world. We might find apparent parallels between traditional Christian sexual ethics and the mating of monogamous higher vertebrates, but what about such oddities as hermaphroditic fish whose partners alternate the roles of male and female in a single mating?

I find delightful irony in the attempt by Norman L. Geisler to use Mount Rushmore as an analogy for his concept of design. This past summer, my family and I stayed briefly at the Rushmore-Borglum campground. This campground-museum complex is run by a born-again Christian who offers Sunday services for the campers. At the service I witnessed, a local stonecutter who had worked on the monument gave his testimony, followed by a sermon

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from a minister who fired some passing shots at evolution.

Here I had always thought that Gutzon Borglum created the faces on Mount Rushmore. Now I hear this stonecutter claiming that *he* played a role! If I follow the creationist logic, either the stonecutter is lying, probably because he has some venal reason for not wanting to believe in Borglum's existence, or he's telling the truth, in which case Borglum never existed. The parallels with the false dichotomy imposed by creationism are clear; Mount Rushmore *was* created by Borglum, who oversaw its execution, but the actual labor was done by people like our stonecutter. Similarly, there is no inherent conflict between a rationally designed universe and evolution, the latter being the actual execution of the design. Certainly design does not imply supernatural creation. Even apparent flaws do not necessarily contradict rational design. Few tourists are aware that Jefferson was originally to have been on Washington's *left*, but the abortive face was blasted away when the rock proved unsound. I doubt that even the most ardent creationist would deny the event (it was filmed) on the grounds that [it] proved that Borglum did not exist!

Geisler repeatedly poses the rhetorical question whether some piece of evidence for natural phenomena in the vicinity of Mount Rushmore in any way argues against the need for an intelligent designer behind the faces on the mountain. A more pertinent question is whether any of Geisler's evidence for a designer argues in any way against the designer relying entirely on the laws of nature to get the job done.

Steven Dutch

The word *design* is altogether used improperly by many scientists and pro-evolution arguers and this falls into the hands of creationists, and Dave Matson's letter in issue XVII is no exception.

The proper term, when referring to internal relationships of "parts" of something, is *structure*. *Design* refers to a plan or intention for something and that plan or intention is *never* in the thing under discussion but in the person who has made the artifact.

The creationists are insisting that the universe and its contents are artifacts. According to their "model," the intention and design are in the mind of "the Creator," and the only way that humans can know of that design or intention is through *revelation* in which "the Creator" lets certain people in on it.

And we know how unreliable that is!

Kenneth H. Bonnell

Being a former creationist, I would like to express my appreciation that *Creation/Evolution* exists. As I went through high school, the *evidence* for evolution was never presented. And

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since I was raised in a fundamentalist atmosphere, it was easy to be convinced by creationist oversimplifications and misrepresentations while in junior high. Even so, as time passed and I began to think more and more in terms of *empirical* data, it became quite evident to me that most persons in this country without scientific training just don't know what science is all about. (And apparently neither do some of the leading creationists, though they do have such training.) Yet, the creationists claim to have real evidence for creation-science, so I believed them, in spite of their erroneous views of what science is.

But then, the Arkansas legislature, while I was in college obtaining a B.S. in chemistry, passed its (in)famous bill. At that provocation, I began some reading on the subject and became convinced that, on the evidence, evolution is true and creation-science is false.

I have been generally pleased with the first fourteen issues of *Creation/Evolution*, especially with the contributions of the professional scientists and those of Mr. Edwords. On the other hand, Dr. Price and Mr. Schadewald have both shown some tendency to be disparaging toward religious belief, and I ask them, are these *ad hominem* tactics necessary to the point? Their articles otherwise are most interesting and informative.

I am writing mainly to comment on Dr. Pine's article in issue XIV. On page eleven, when discussing explanations of phemonena, he writes: "The supernatural one may be right but there's no way to get there from here." This means that, though the "supernatural" explanation may be true, we can never know its truth-value. This relegates such an explanation to the level of mere opinion. It also becomes worthless, after the fashion of Omphalos. It is an unfortunate tendency of our time that many persons feel that religion is merely a matter of taste and opinion rather than a matter of fact. I have seen this opinion and its consequences expressed in *Creation/Evolution* several times.

I maintain that true religion is no more merely a matter of opinion than is true science. It is a matter of evidence. I have seen all of the non-empirical arguments for the existence of God, and none suffice. I believe revelation is the only evidence for the existence of a supernatural being, and miracles provide that evidence. For example, my religious faith rests in the historicity of one event, and that is the resurrection of Jesus of Nazareth. If he rose from the dead, my faith in God to save me is justified. If he did not rise, then I agree with the Apostle Paul (I Corinthians 15:12–17) that my faith is vain. The first-century Christians were empiricists also, it seems. The Resurrection: it either happened or not. It is a matter of historical, empirical evidence.

I stress this because, although science can know nothing of God or other "supernatural" beings, if such a being were to reveal itself (that is, perform a miracle), it would of necessity act in a manner that is empirically

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observable. If God created the world in the manner in which the creationists claim that he did, would the data support them? I believe the answer is yes. The creationists are not simply saying, "The world is the way it is because that's the way God made it." That is not an empirical statement; it could mean anything or nothing. As Dr. Pine noted, it may very well be true. But it is not an explanation, and its truth-value can only be ascertained indirectly. Fortunately, the creation-scientists don't believe it's an explanation either, and they've put forth a scheme which is clearly testable and therefore empirical. If not, then why such an effort to show that creation-science is false?

Patrick Guthrie

I must correct Paul Pfalzner's criticism of Ronald Pine ("Letters to the Editor," *Creation/Evolution XVII*). Pfalzner attacks Pine's "timid agnostic stance" in regard to the supernatural, and categorically proclaims that "the scientist has . . . a duty to declare the 'supernatural' to be a nullity and to demand that the burden of proof . . . be placed on those who profess to believe in [the supernatural]." Any supernaturalism, and any discussion of the same, is simply beyond science. Any judgment, pro or con, made in regard to the supernatural is a philosophical (or theological) judgment—not a scientific one. A professional scientist, it must be remembered, is usually an amateur when it comes to philosophy. I must challenge the positivistic dogma that any scientist, regardless of his or her level of philosophic training or lack thereof, has an *ipso facto* right to make an authoritative philosophic statement. Pfalzner's view is, I am sure, highly offensive to some of the most valuable people in the cause—theistic evolutionist scientists and laypersons! A supporter of evolution or a staunch enemy of creationism should be accepted on his or her own terms and not subjected to criticism on the grounds of philosophic inclination, religious preference, or other tangential, extraneous considerations.

Jeffrey V. Governale

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